



# Mark Scheme (Results)

January 2016

Pearson Edexcel International  
Advanced Level in Chemistry  
(WCH02) Paper 01 – Application of  
Core Principles of Chemistry

## Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications come from Pearson, the world's leading learning company. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information, please visit our website at [www.edexcel.com](http://www.edexcel.com).

Our website subject pages hold useful resources, support material and live feeds from our subject advisors giving you access to a portal of information. If you have any subject specific questions about this specification that require the help of a subject specialist, you may find our Ask The Expert email service helpful.

[www.edexcel.com/contactus](http://www.edexcel.com/contactus)

## **Pearson: helping people progress, everywhere**

Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at:

[www.pearson.com/uk](http://www.pearson.com/uk)

January 2016

Publications Code IA043125\*

All the material in this publication is copyright

© Pearson Education Ltd 2016

## General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.
- Mark schemes will indicate within the table where, and which strands of QWC, are being assessed. The strands are as follows:
  - i) ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear
  - ii) select and use a form and style of writing appropriate to purpose and to complex subject matter
  - iii) organise information clearly and coherently, using specialist vocabulary when appropriate

## Using the Mark Scheme

Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean allowing candidates to be rewarded for answers showing correct application of principles and knowledge. Examiners should therefore read carefully and consider every response: even if it is not what is expected it may be worthy of credit.

The mark scheme gives examiners:

- an idea of the types of response expected
- how individual marks are to be awarded
- the total mark for each question
- examples of responses that should NOT receive credit.

/ means that the responses are alternatives and either answer should receive full credit.

( ) means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.

Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.

ecf/TE/cq (error carried forward) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

Candidates must make their meaning clear to the examiner to gain the mark. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

### Quality of Written Communication

Questions which involve the writing of continuous prose will expect candidates to:

- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities.

Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

**Section A**

| Question Number | Correct Answer | Mark     |
|-----------------|----------------|----------|
| <b>1</b>        | B              | <b>1</b> |

| Question Number | Correct Answer | Mark     |
|-----------------|----------------|----------|
| <b>2</b>        | D              | <b>1</b> |

| Question Number | Correct Answer | Mark     |
|-----------------|----------------|----------|
| <b>3</b>        | A              | <b>1</b> |

| Question Number | Correct Answer | Mark     |
|-----------------|----------------|----------|
| <b>4</b>        | B              | <b>1</b> |

| Question Number | Correct Answer | Mark     |
|-----------------|----------------|----------|
| <b>5</b>        | C              | <b>1</b> |

| Question Number | Correct Answer | Mark     |
|-----------------|----------------|----------|
| <b>6</b>        | D              | <b>1</b> |

| Question Number | Correct Answer | Mark     |
|-----------------|----------------|----------|
| <b>7</b>        | D              | <b>1</b> |

| Question Number | Correct Answer | Mark     |
|-----------------|----------------|----------|
| <b>8</b>        | C              | <b>1</b> |

| Question Number | Correct Answer | Mark     |
|-----------------|----------------|----------|
| <b>9</b>        | B              | <b>1</b> |

| Question Number | Correct Answer | Mark     |
|-----------------|----------------|----------|
| <b>10</b>       | A              | <b>1</b> |

| Question Number | Correct Answer | Mark     |
|-----------------|----------------|----------|
| <b>11</b>       | B              | <b>1</b> |

| Question Number | Correct Answer | Mark     |
|-----------------|----------------|----------|
| <b>12</b>       | A              | <b>1</b> |

| Question Number | Correct Answer | Mark     |
|-----------------|----------------|----------|
| <b>13</b>       | A              | <b>1</b> |

| Question Number | Correct Answer | Mark     |
|-----------------|----------------|----------|
| <b>14</b>       | D              | <b>1</b> |

| Question Number | Correct Answer | Mark     |
|-----------------|----------------|----------|
| <b>15</b>       | B              | <b>1</b> |

| Question Number | Correct Answer | Mark     |
|-----------------|----------------|----------|
| <b>16</b>       | C              | <b>1</b> |

| Question Number | Correct Answer | Mark     |
|-----------------|----------------|----------|
| <b>17</b>       | C              | <b>1</b> |

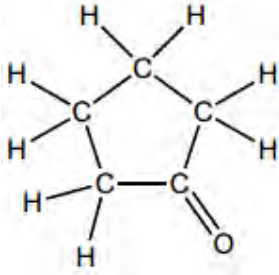
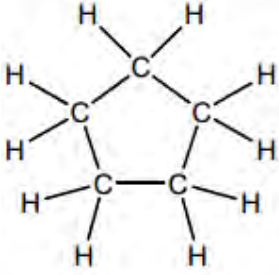
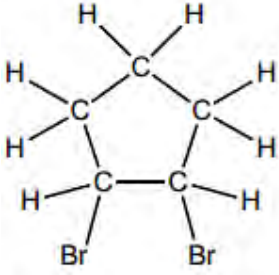
| Question Number | Correct Answer | Mark     |
|-----------------|----------------|----------|
| <b>18</b>       | D              | <b>1</b> |

| Question Number | Correct Answer | Mark     |
|-----------------|----------------|----------|
| <b>19</b>       | D              | <b>1</b> |

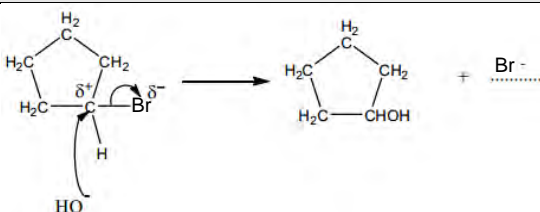
| Question Number | Correct Answer | Mark     |
|-----------------|----------------|----------|
| <b>20</b>       | B              | <b>1</b> |

**(Total for Section A = 20 marks)**

## Section B

| Question Number | Acceptable Answers   | Reject | Mark     |
|-----------------|--|--------|----------|
| 21 (a)          | <div style="text-align: center;">  <p>Compound <b>A</b> (1)</p>  <p>Compound <b>B</b> (1)</p>  <p>Compound <b>C</b> (1)</p> <p>Max <b>2</b> if any H atoms are missing from one or more structures</p> <p>ALLOW<br/>Correct 'rotated' structures<br/>CH<sub>2</sub> un-displayed</p> </div> |        | <b>3</b> |

| Question Number | Acceptable Answers   | Reject                                   | Mark     |
|-----------------|--|--|----------|
| <b>21 (b)</b>   | <p>(From) Orange OR brown</p> <p>ALLOW<br/>Shades of orange or yellow or brown including red-brown/reddish-brown OR 'red' if used as a 'qualifier' for a correct colour</p> <p>(To) <b>Colourless</b></p> <p>IGNORE<br/>'Clear'</p> <p><b>Both colours</b> are needed for the mark</p> | <b>Just</b> 'red' for the initial colour | <b>1</b> |

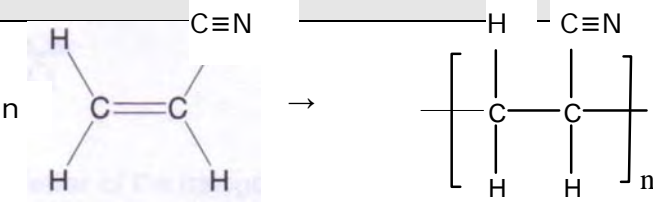
| Question Number   | Acceptable Answers   | Reject  | Mark     |
|-------------------|--|---|----------|
| <b>21 (c) (i)</b> |  <p><b>First mark – M1:</b></p> <p>Curly arrow from anywhere* on the OH<sup>-</sup> ion to C atom of C—Br bond <b>and</b> dipole shown on C—Br bond, C<sup>δ+</sup> and Br<sup>δ-</sup></p> <p>IGNORE<br/>δ- on OH<sup>-</sup> ion</p> <p style="text-align: right;"><b>(1)</b></p> <p><b>Second mark – M2:</b></p> <p>Curly arrow from the C—Br bond to the Br atom</p> <p style="text-align: right;"><b>(1)</b></p> <p><b>Third mark – M3:</b></p> <p>Br<sup>-</sup> as the co-product</p> <p style="text-align: right;"><b>(1)</b></p> <p>IGNORE intermediates or transition states even if incorrect</p> | <p>*If <b>lone pair of e<sup>-</sup></b> is shown on the <b>H</b> of the OH<sup>-</sup> ion, no M1</p> <p><b>Just</b> 'Br'</p> <p>NaBr /<br/>Na<sup>+</sup>Br<sup>-</sup> /<br/>HBr</p> | <b>3</b> |



| Question Number    | Acceptable Answers   | Reject | Mark     |
|--------------------|--|--------|----------|
| <b>21 (c) (ii)</b> | (Type of reaction) <b>substitution (1)</b><br><b>IGNORE</b><br>'hydrolysis'<br>(Mechanism) <b>nucleophilic (1)</b><br><br>ALLOW<br>These words in either order or on one line<br><br><b>Just S<sub>N</sub>1 or S<sub>N</sub>2 scores 1</b><br><br>(Otherwise IGNORE S <sub>N</sub> 1 or S <sub>N</sub> 2 if given with correct answer(s))<br><br>NOTE<br>Spelling does not have to be 100% accurate, so long as the meaning is clear |        | <b>2</b> |

| Question Number     | Acceptable Answers  | Reject    | Mark     |
|---------------------|---|-----------|----------|
| <b>21 (c) (iii)</b> | <b>Heterolytic</b> (fission)<br><br>NOTE<br>Spelling does not have to be 100% accurate, so long as the meaning is clear | Homolytic | <b>1</b> |

(Total for Question 21 = 10 marks)

| Question Number | Acceptable Answers  | Reject   | Mark     |
|-----------------|---|--|----------|
| 22 (a)          |  <p>ALLOW CN for C≡N throughout<br/>IGNORE 'connectivity' to the C≡N / CN group</p> <p><b>First mark – M1:</b><br/>Two "n" in the equation and a correct formula (molecular or structural or displayed) for propenenitrile on LHS of the equation<br/>LHS "n" must be to left of the monomer<br/>RHS "n" must be a <b>subscript</b></p> <p>IGNORE<br/>Any square or round brackets around monomer on LHS<br/><b>(1)</b></p> <p><b>Second mark – M2:</b><br/>One correct <b>displayed</b> repeat unit (with or without a bracket or "n" shown in the equation)<br/><b>(1)</b></p> <p><b>Third mark – M3:</b><br/>Continuation bond at each end of the repeat unit (with or without a bracket or "n" shown in the equation)<br/><b>(1)</b></p> <p><b>NOTE</b><br/>M3 is awarded for the two continuation bonds, even if the repeat unit given is incorrect</p> <p>Polymer containing a C=C scores max <b>(1)</b></p> <p><b>Additional comment</b><br/>Mark the three scoring points independently</p> | No M2 mark if <b>more than one</b> repeat unit shown | <b>3</b> |

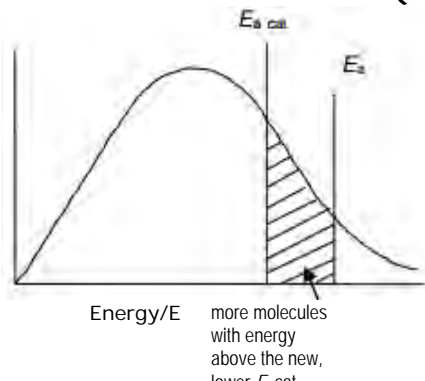
| Question Number | Acceptable Answers   | Reject  | Mark     |
|-----------------|--|---|----------|
| <b>22 (b)</b>   | (It is an) addition reaction<br>OR<br>An addition polymer is made<br>OR<br>All the reactants are made into the desired / required product<br>OR<br>Only one product (is made)<br>OR<br>No waste products / no by-products<br><br>ALLOW<br>No 'side' products | <b>Just</b> 'all the product is useful'<br><br><b>Just</b> 'all the reactants become products'<br><br>'No product wasted' | <b>1</b> |

| Question Number                | Acceptable Answers  | Reject | Mark     |
|--------------------------------|---|--------|----------|
| <p><b>22</b><br/>* (c) (i)</p> | <p><b>First mark – M1:</b><br/>(Position of equilibrium shifts/'favours')</p> <p>to the left<br/>OR<br/>to the reactants<br/>OR<br/>to the backward reaction/direction<br/>OR<br/>to the reverse reaction/direction<br/>OR<br/>towards C<sub>3</sub>H<sub>6</sub> / NH<sub>3</sub> / O<sub>2</sub></p> <p>ALLOW<br/>decreases yield of products /<br/>decreases yield of CH<sub>2</sub>CHCN /<br/>decreases yield of H<sub>2</sub>O</p> <p style="text-align: right;"><b>(1)</b></p> <p><b>Second mark – M2:</b><br/><b>This mark is dependent on the correct change in THE position of equilibrium</b><br/><b>(i.e. (0) overall for question if states that eq'm shifts to the RIGHT)</b></p> <p>(Forward) reaction is exothermic<br/>OR<br/>(Forward) reaction gives out heat<br/>OR<br/>Backward reaction is endothermic / takes in heat<br/>OR<br/>Reverse reaction is endothermic / takes in heat<br/>IGNORE<br/>References to just "decreasing the temperature" / "opposes the increase in temperature"</p> <p style="text-align: right;"><b>(1)</b></p> <p><b>Additional comment</b><br/>JUST a statement that it "moves in / favours the endothermic direction" can get M1 ONLY IF M2 has already been awarded (as it is then clear that the candidate realises that from right to left <b>is</b> the endothermic direction).</p> |        | <b>2</b> |

| Question Number                 | Acceptable Answers   | Reject   | Mark            |
|---------------------------------|--|--|-----------------|
| <p><b>22</b><br/>* (c) (ii)</p> | <p><b>First mark – M1:</b><br/>(Position of equilibrium shifts/'favours')</p> <p>to the left<br/>OR<br/>to the reactants<br/>OR<br/>to the backward reaction/direction<br/>OR<br/>to the reverse reaction/direction<br/>OR<br/>towards C<sub>3</sub>H<sub>6</sub> / NH<sub>3</sub> / O<sub>2</sub></p> <p>ALLOW<br/>decreases yield of products /<br/>decreases yield of CH<sub>2</sub>CHCN /<br/>decreases yield of H<sub>2</sub>O</p> <p style="text-align: right;"><b>(1)</b></p> <p><b>Second mark – M2:</b><br/><b>This mark is dependent on the correct change in THE position of equilibrium</b><br/><b>(i.e. (0) overall for question if states that eq'm shifts to the RIGHT)</b></p> <p>Right-hand side has more moles/molecules (of gas)<br/>OR<br/>Products have more moles/molecules (of gas)<br/>OR<br/>Left-hand side has fewer moles/molecules (of gas)<br/>OR<br/>Reactants have fewer moles/molecules (of gas)</p> <p><b>NOTE:</b><br/>2nd mark awarded if mentions:<br/><b>3½ moles/molecules (of gas) on LHS and</b><br/><b>4 moles/molecules (of gas) on RHS</b></p> <p style="text-align: right;"><b>(1)</b></p> | <p>References to ATOMS/PARTICLES, if chooses to refer to these, (instead of molecules)<br/>no 2nd mark</p> | <p><b>2</b></p> |

| Question Number   | Acceptable Answers  | Reject                                 | Mark     |
|-------------------|---|--|----------|
| <b>22 (d) (i)</b> | (y-axis:) Fraction of molecules / number of molecules<br>ALLOW<br>Proportion of molecules<br>ALLOW<br>'particles' instead of molecules for the label on the y-axis<br><br><b>and</b><br><br>(x-axis:) Energy / $E$ / kinetic energy<br><br>NOTE:<br><b>BOTH</b> graphs' axes (on p14 and p15 of script) need to be labelled correctly for this mark | 'atoms' instead of molecules/particles | <b>1</b> |

| Question Number                       | Acceptable Answers   | Reject  | Mark            |
|---------------------------------------|--|---|-----------------|
| <p><b>*22</b><br/><b>(d) (ii)</b></p> | <p><b>First mark – M1:</b><br/>Correct drawing of Maxwell-Boltzmann distribution at <math>T_2</math> clearly identified<br/>NOTE<br/>As long as it is clear which curve the candidate has drawn, if it is correctly drawn award this mark, even if their curve is not actually labelled "<math>T_2</math>"</p> <p><b>NOTE</b><br/><b>Peak</b> of candidate's curve (at the higher temperature) should be clearly <b>lower and to the right</b> of that at the lower temperature<br/><b>(1)</b></p> <p><b>Second mark – M2:</b><br/>Suitable <math>E_a</math> shown on graph<br/><b>(1)</b></p> <p><b>Third mark – M3:</b><br/>(At higher temperature) more molecules/more collisions / more particles have <b>energy greater than the activation energy</b><br/><b>(1)</b></p> <p>NOTE: Must refer to activation energy / <math>E_a</math> for M3<br/>IGNORE 'more frequent collisions'</p> <div style="text-align: center;"> </div> <p>Only M1 can be awarded if <b>two</b> <math>E_a</math> values drawn on graph for this part</p> | <p><math>E_a</math> shown at peak or to the left of peak</p> <p>"More <b>atoms</b>"</p> | <p><b>3</b></p> |

| Question Number                  | Acceptable Answers   | Reject   | Mark  |
|----------------------------------|--|--|---|
| <p><b>22</b><br/>* (d) (iii)</p> | <p><b>First mark – M1:</b><br/> <math>E_a</math> for the <b>catalysed reaction</b> shown to the <b>left</b> of <math>E_a</math> for the <b>un-catalysed reaction</b></p> <p>NOTE<br/>                     Do not penalise again the actual position of either <math>E_a</math> if M2 was not awarded in Q22(d)(ii) for the same reason</p> <p style="text-align: right;"><b>(1)</b></p> <p><b>Second mark – M2:</b><br/> <b>EITHER</b><br/>                     (With catalyst) more molecules / more collisions / more particles have energy greater than the (new, lower) activation energy<br/> <b>OR</b><br/>                     Diagram labelled as shown below</p> <p>NOTE<br/>                     If a shaded area is shown between the two <math>E_a</math> lines, even if it is unlabelled, award M2</p> <p>NOTE<br/>                     ALLOW alternatives for <b>M2</b> such as<br/>                     "More molecules have enough energy to react (with the catalyst)"<br/> <b>OR</b><br/>                     "More molecules are able to react at lower energies (with the catalyst)"<br/>                     [Unlike in Q22(d)(i), <math>E_a</math> doesn't HAVE to be mentioned.]</p> <p style="text-align: right;"><b>(1)</b></p> <div style="text-align: center;">  </div> <p>IGNORE<br/> <b>Just</b> a statement that "a catalyst provides an alternative reaction route/pathway of lower activation energy"</p> | <p>Two curves shown (no M1)</p> <p>"More <b>atoms</b>"</p> | <p style="text-align: center;"><b>2</b></p> |

**(Total for Question 22 = 14 marks)**



| Question Number | Acceptable Answers                                       | Reject                                 | Mark     |
|-----------------|--|--|----------|
| <b>23(a)(i)</b> | Any value or range of values from pH 8 to 13 (inclusive) | <b>Just</b> greater / > than any value | <b>1</b> |

| Question Number  | Acceptable Answers  | Reject | Mark     |
|------------------|---|--------|----------|
| <b>23(a)(ii)</b> | $\text{Ca(OH)}_2(\text{aq}) + \text{CO}_2(\text{g}) \rightarrow \text{CaCO}_3(\text{s}) + \text{H}_2\text{O}(\text{l})$<br><b>M1</b> - All four species are correct (1)<br><b>M2</b> - State symbols all correct (1)<br><br>M2 can only be awarded for the correct state symbols if M1 has already been awarded OR for a 'near-miss' equation with species almost correct |        | <b>2</b> |

| Question Number | Acceptable Answers        | Reject | Mark     |
|-----------------|---------------------------|--------|----------|
| <b>23(b)(i)</b> | Three / 3 (moles of ions) |        | <b>1</b> |

| Question Number  | Acceptable Answers            | Reject | Mark     |
|------------------|-------------------------------|--------|----------|
| <b>23(b)(ii)</b> | Ten / 10 (moles of electrons) |        | <b>1</b> |

| Question Number | Acceptable Answers   | Reject  | Mark     |
|-----------------|--|---|----------|
| 23 (c)          | <p><b>Mark independently:</b></p> <p><b>First mark – M1:</b><br/>Heat (strongly) <math>\text{CaCO}_3</math></p> <p>ALLOW<br/>'thermal decomposition' / 'thermally decompose' / 'high temperature'<br/><b>(1)</b></p> <p><b>Second mark – M2:</b><br/><math>\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2</math></p> <p>IGNORE<br/>State symbols, even if incorrect<br/><b>(1)</b></p> <p>NOTE<br/>The correct equation for M2 with 'heat' or just a '<math>\Delta</math>' written above the arrow would also score M1.</p> <p><b>Third mark – M3:</b><br/>Add (a few drops of) water to <b>CaO</b></p> <p>ALLOW<br/>If <math>\text{CaO} + \text{H}_2\text{O}(\text{l})/\text{H}_2\text{O}</math> seen on the LHS of any equation, even if the equation overall is incorrect<br/><b>(1)</b></p> <p><b>Fourth mark:</b><br/><math>\text{CaO} + \text{H}_2\text{O} \rightarrow \text{Ca}(\text{OH})_2</math></p> <p>IGNORE<br/>State symbols, even if incorrect<br/><b>(1)</b></p> | <p>No M1 if refers to 'oxidation' of <math>\text{CaCO}_3</math> when heated / Heating <math>\text{CaCO}_3</math> in a sealed tube / closed apparatus</p> <p>Add 'steam' to CaO<br/>Adding water to <b>CaCO<sub>3</sub></b><br/>Adding water to <b>Ca</b><br/>Use of heat / gentle heat / use of warm water /<br/>Forming <math>\text{Ca}(\text{OH})_2</math> <b>solution</b> /<br/>'Dissolve the CaO in water' /<br/>Drying or heating the <math>\text{Ca}(\text{OH})_2</math> product<br/>All no M3</p> <p><math>\text{CaO} + 2\text{H}_2\text{O} \rightarrow \text{Ca}(\text{OH})_2 + \text{H}_2</math></p> | <b>4</b> |

| Question Number   | Acceptable Answers  | Reject | Mark     |
|-------------------|---|--------|----------|
| <b>23 (d) (i)</b> | $2\text{SO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l}) + \text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{SO}_4(\text{aq})$ <p><b>ALLOW</b><br/>Multiples</p> <p><b>M1</b> - Species and balancing (1)</p> <p><b>M2</b> - All state symbols correct</p> <p>M2 can only be awarded for the correct state symbols if M1 has already been awarded OR for a 'near-miss' equation with the species almost correct</p> <p>(1)</p> |        | <b>2</b> |

| Question Number    | Acceptable Answers  | Reject | Mark     |
|--------------------|---|--------|----------|
| <b>23 (d) (ii)</b> | <p>CaO is basic / is a base / is a metal oxide<br/>OR<br/>CaO <b>neutralizes</b> (acidic) SO<sub>2</sub> / H<sub>2</sub>SO<sub>4</sub><br/>OR<br/>CaO reacts with a <b>non-metal oxide</b> (SO<sub>2</sub>)<br/>OR<br/>Basic oxides react with acidic gases</p> <p><b>ALLOW</b><br/>Alkaline for basic/ alkali for base</p> <p><b>IGNORE</b><br/>References to forming a salt / formation of calcium sulfate</p> <p>References to the large surface area of powder / effect on rate of reaction</p> |        | <b>1</b> |

| Question Number               | Acceptable Answers  | Reject   | Mark     |
|-------------------------------|---|--|----------|
| <b>23</b><br><b>(d) (iii)</b> | <p><b>NOTE:</b><br/><b>Can only award scoring point for the environmental problem if it is linked to the correct substance</b><br/><b>Substance mark (M1) stand-alone</b><br/>Carbon dioxide/ CO<sub>2</sub> (1)<br/>with<br/>Global warming<br/>OR<br/>Greenhouse effect<br/>ACCEPT as an alternative a description of the above phenomenon<br/>IGNORE acid rain for CO<sub>2</sub> (1)</p> <p><b>OR</b></p> <p>Carbon particulates / soot (1)<br/>with<br/>Breathing difficulties / breathing disorders / carcinogenic / 'blocking out' sky / blackening of buildings / covering buildings (1)</p> <p>ALLOW</p> <p>Nitrogen dioxide/ NO<sub>2</sub> OR nitrogen monoxide/ NO (1)<br/>with<br/>Destruction of ozone layer/breathing problems<br/>IGNORE acid rain for NO<sub>2</sub> (1)</p> <p>ALLOW<br/>Carbon monoxide/ CO (1)<br/>with<br/>(Highly) toxic (gas) / poisonous / 'lethal' (gas) (1)</p> | <p>SO<sub>2</sub> / SO<sub>3</sub> / H<sub>2</sub>SO<sub>3</sub> / H<sub>2</sub>SO<sub>4</sub> scores <b>(0)</b> for question as already mentioned earlier</p> <p>2nd mark for 'ozone depletion' IF this is linked to CO<sub>2</sub></p> | <b>2</b> |

(Total for Question 23 = 14 marks)

| Question Number   | Acceptable Answers  | Reject   | Mark     |
|-------------------|---|--|----------|
| <b>24 (a) (i)</b> | <p>FIRST, CHECK THE FINAL ANSWER</p> <p>IF answer<br/> <math>\text{IO}_3^- + 6 \text{H}^+ + 5 \text{I}^- \rightarrow 3 \text{I}_2 + 3 \text{H}_2\text{O}</math><br/>           (ALLOW multiples)<br/>           then award <b>(2)</b> marks, with or without any working</p> <p>OTHERWISE</p> <p><b>First mark:</b><br/>           Any evidence of correctly multiplying the half-equations in order to cancel electrons</p> <p>(e.g. second equation x 5<br/>           OR<br/>           first equation x 2 and second equation x 10)</p> <p style="text-align: right;"><b>(1)</b></p> <p><b>Second mark:</b><br/>           For correctly balanced equation overall<br/> <math>\text{IO}_3^- + 6 \text{H}^+ + 5 \text{I}^- \rightarrow 3 \text{I}_2 + 3 \text{H}_2\text{O}</math></p> <p>OR</p> $2 \text{IO}_3^- + 12 \text{H}^+ + 10 \text{I}^- \rightarrow 6 \text{I}_2 + 6 \text{H}_2\text{O}$ <p style="text-align: right;"><b>(1)</b></p> <p>IGNORE<br/>           State symbols, even if incorrect</p> | <p>NO <b>2nd mark</b> if<br/> <math>\text{e}^-</math> un-cancelled<br/>           on LHS and RHS<br/>           in balanced eqtn</p> | <b>2</b> |

| Question Number    | Acceptable Answers  | Reject | Mark     |
|--------------------|---|--------|----------|
| <b>24 (a) (ii)</b> | <p><math>\text{IO}_3^-</math> / <math>\text{NaIO}_3</math><br/> <b>and</b><br/> <b>gains electrons</b> (from the iodide ions)<br/>           ALLOW 'electron gain' (singular)</p> <p>IGNORE<br/>           References to iodate(<b>V</b>) or sodium iodate</p> <p>NOTE:<br/>           IGNORE <b>Just</b> correct changes in oxidation number, as answer requires reference to <b>gain of electrons</b></p> |        | <b>1</b> |

| Question Number   | Acceptable Answers      | Reject          | Mark     |
|-------------------|-------------------------|-----------------|----------|
| <b>24 (b) (i)</b> | Iodine / I <sub>2</sub> | <b>Just 'I'</b> | <b>1</b> |

| Question Number    | Acceptable Answers   | Reject  | Mark     |
|--------------------|--|---|----------|
| <b>24 (b) (ii)</b> | <p><math>\text{H}_2\text{SO}_4 + 6\text{H}^+ + 6\text{e}^- \rightarrow \text{S} + 4\text{H}_2\text{O}</math><br/> <b>OR</b><br/> <math>\text{SO}_4^{2-} + 8\text{H}^+ + 6\text{e}^- \rightarrow \text{S} + 4\text{H}_2\text{O}</math><br/> <b>OR</b><br/> <math>8\text{SO}_4^{2-} + 64\text{H}^+ + 48\text{e}^- \rightarrow \text{S}_8 + 32\text{H}_2\text{O}</math><br/> <b>(2)</b></p> <p>IGNORE<br/>                     State symbols, even if incorrect</p> <p><b>First mark – M1:</b><br/>                     All species correct<br/> <b>(1)</b></p> <p><b>Second mark – M2:</b><br/>                     Balancing</p> <p>M2 can only be awarded if the correct species mark (M1) has been awarded<br/> <b>(1)</b></p> <p>ACCEPT<br/>                     Multiples</p> | <p>S<sub>2</sub> or S<sub>4</sub> for sulfur</p> <p>e<sup>-</sup> on wrong side (no M1)</p> | <b>2</b> |

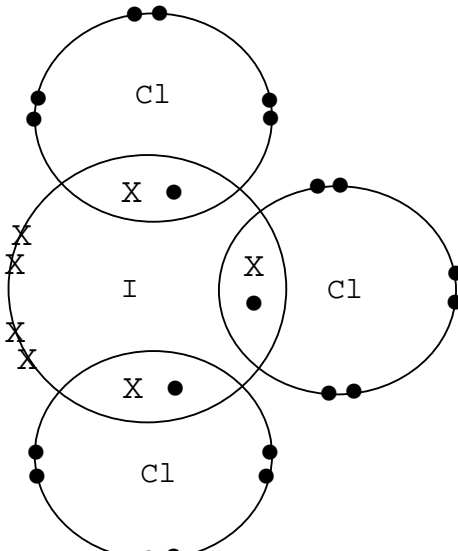
| Question Number     | Acceptable Answers   | Reject    | Mark     |
|---------------------|--|-----------|----------|
| <b>24 (b) (iii)</b> | <p><b>M1 - (Identity of X)</b></p> <p>H<sub>2</sub>S / hydrogen sulfide / hydrogen sulphide<br/> <b>(1)</b></p> <p><b>M2 - (this is a stand-alone mark) -</b><br/>                     (Oxidation number of S in sulfuric acid)<br/>                     +6</p> <p>ALLOW<br/>                     6 or "6+ "<br/> <b>(1)</b></p> <p><b>M3 - (Oxidation number of S in X)</b><br/>                     -2<br/>                     ALLOW 2-<br/>                     No TE on incorrect X<br/> <b>(1)</b></p> | <p>+4</p> | <b>3</b> |

| Question Number | Acceptable Answers   | Reject | Mark     |
|-----------------|--|--------|----------|
| 24 (c) (i)      | <p>FIRST CHECK THE ANSWER ON ANSWER LINE,<br/>IF answer = 183 (<math>\mu\text{g}</math>),<br/><b>N.B. must be 3 sf</b>,<br/>then award <b>(2)</b> marks, with or without any working</p> <p>OTHERWISE look for:</p> <p><b>1st mark – M1</b><br/>EITHER<br/>(Moles of <math>\text{I}^-</math>) = <math>140 \times 10^{-6} \div 126.9</math><br/>OR<br/>(Moles of <math>\text{I}^-</math>) = <math>140 \times 10^{-6} \div 127</math><br/>OR<br/>(Moles of <math>\text{I}^-</math>) = <math>1.1(0) \times 10^{-6}</math> (mol)</p> <p>ALSO ALLOW<br/><math>140 \div 126.9</math><br/>OR<br/><math>140 \div 127</math><br/>for M1</p> <p style="text-align: right;"><b>(1)</b></p> <p><b>2nd mark – M2</b><br/>(Mass of KI)<br/>= mol of <math>\text{I}^- \times 166 \div 10^{-6}</math> <b>and 3 s.f.</b><br/>[NOTE: Expected answer:<br/><math>[(1.1(0) \times 10^{-6} / 10^{-6}) \times 166]</math><br/>= 183(<math>\mu\text{g}</math>) <b>to 3 sf</b></p> <p>2nd mark is CQ on moles of <math>\text{I}^-</math> calculated</p> <p>ALLOW<br/><math>140 \times 166 \div 126.9</math> for M2<br/>OR<br/><math>140 \times 166 \div 127</math> for M2<br/>ALLOW</p> <p><math>M_r</math> for KI as 166 or 166.1 or 165.9</p> <p style="text-align: right;"><b>(1)</b></p> |        | <b>2</b> |

| Question Number    | Acceptable Answers   | Reject  | Mark     |
|--------------------|--|---|----------|
| <b>24 (c) (ii)</b> | <p>Any ONE of:</p> <p>(Morally) wrong to put additives in food supplies;</p> <p>People should be able to choose if I<sup>-</sup> is added to their food;</p> <p>Food / tap water already has sufficient I<sup>-</sup> (from other sources);</p> <p>Other foodstuffs contain I<sup>-</sup>;</p> <p><b>Excess</b> K<sup>+</sup> (ions) harmful;</p> <p><b>Excess</b> I<sup>-</sup> (ions) harmful;</p> <p>Any reference to radioactivity;</p> <p>Allergies/intolerance (to I<sup>-</sup>);</p> <p>Raises blood pressure;</p> <p>Any reference to thyroid issues</p> <p>NOTE<br/>ALLOW 'dangerous' for 'harmful'</p> <p>IGNORE<br/>Any references to cost</p> | <p>KI/I<sup>-</sup> 'toxic' or 'poisonous';</p> <p>References to just "K" or "I" or "I<sub>2</sub>";</p> <p>"KI reacts with (stomach) acid";</p> <p>(KI) difficult to obtain;</p> <p>(KI) difficult to prepare;</p> <p>(KI) difficult to store;</p> <p>(KI) not readily available;</p> <p>(KI) strong reducing agent;</p> <p>(KI) bad taste</p> | <b>1</b> |



| Question Number | Acceptable Answers  | Reject   | Mark |
|-----------------|---|--|------|
| 24 (d) (i)      | <p><b>First mark (M1)</b><br/>           ICl has permanent dipole (-permanent dipole) forces<br/>           OR<br/>           ICl has dipole-dipole forces</p> <p>IGNORE<br/> <b>Just</b> I–Cl bond is polar or <b>just</b> ICl is a polar molecule<br/>           (1)</p> <p><b>Second mark (M2)</b><br/>           Cl<sub>2</sub> has London forces /<br/>           Cl<sub>2</sub> has van der Waals' forces /<br/>           Cl<sub>2</sub> has dispersion forces /<br/>           Cl<sub>2</sub> has INDUCED-dipole forces/<br/>           temporary dipole forces<br/>           (1)</p> <p><b>Third mark (M3)</b><br/>           Any suggestion that the intermolecular forces / any named intermolecular forces / any 'interactions' between molecules are <b>stronger in ICl</b> (than in Cl<sub>2</sub>) / need more (heat) energy to overcome forces in ICl<br/> <b>OR</b><br/>           Mentions that ICl has BOTH London AND permanent dipole forces<br/>           (1)</p> <p><b>Fourth mark (M4)</b><br/> <b>EITHER</b><br/>           ICl has <b>stronger</b> London forces / <b>stronger</b> van der Waals' forces / <b>stronger</b> dispersion forces (than Cl<sub>2</sub>)<br/> <b>OR</b><br/>           ICl has more electrons (per molecule than Cl<sub>2</sub>) / ICl larger molecule (than Cl<sub>2</sub>)<br/>           (1)</p> | <p>Reference to ionic bonds (no M3)</p> <p>Reference to/implication of the breaking of ionic bonds or covalent bonds or hydrogen bonds or ambiguity as to what interactions are being broken (no M3)</p> | 4    |

| Question Number | Acceptable Answers  | Reject | Mark |
|-----------------|---|--------|------|
| 24<br>(d)(ii)   | <p>2 lone pairs on the iodine (1)</p> <p>Rest of molecule correct<br/>(i.e. 3 I-Cl bond pairs <b>and</b> 3 lone pairs on each Cl atom) (1)</p>  <p>IGNORE<br/>Inner-shell electrons<br/>Circles are not required</p> <p>NOTE<br/>Must use the dot and cross convention to distinguish the electrons</p> <p>ALLOW<br/>Lone pair electrons shown separately rather than in pairs (totals of the non-bonding electrons <b>must</b> be correct)</p> |        | 2    |

| Question Number | Acceptable Answers   | Reject  | Mark |
|-----------------|--|---|------|
| 24 (e)(i)       | <p><math>\text{Cl}_2 + 2\text{I}^- \rightarrow 2\text{Cl}^- + \text{I}_2</math></p> <p>ALLOW multiples</p> <p>IGNORE<br/>State symbols, even if incorrect</p> <p>Full equation <b>also</b> given</p> | If $\text{K}^+$ ions are left in the equation | 1    |

| Question Number | Acceptable Answers   | Reject  | Mark     |
|-----------------|--|---|----------|
| *24<br>(e) (ii) | <p>(So from 0.66 mol NaI)</p> <p><b>0.33 mol I<sub>2</sub> formed</b> (1)</p> <p>(So) <b>0.17 mol Br<sub>2</sub> formed</b> (1)</p> <p><b>NOTE:</b><br/> <b>0.33 mol I<sub>2</sub> scores (1)</b>, with or without working<br/> <b>0.17 mol Br<sub>2</sub> scores (1)</b>, with or without working</p> <p><b>M3 - [Justification] Stand alone</b></p> <p>EITHER</p> <p>I<sup>-</sup> has greater reducing power (than Br<sup>-</sup>)</p> <p>OR</p> <p>NaI has greater reducing power (than NaBr)</p> <p>OR</p> <p>Reducing power (of the halide ions) increases down the group</p> <p>OR</p> <p>I<sup>-</sup> more easily oxidised (than Br<sup>-</sup>)</p> <p>(1)</p> | <p>TE on incorrect moles of I<sub>2</sub> or incorrect moles of Br<sub>2</sub></p> <p>Iodine/I<sub>2</sub> has greater reducing power than bromine/Br<sub>2</sub></p> | <b>3</b> |

(Total for Question 24 = 22 marks)

**TOTAL FOR PAPER = 80 marks**