

# Mark Scheme (Results)

Summer 2016

Pearson Edexcel GCE  
in Chemistry (6CH02) Paper 01  
Application of Core Principles of  
Chemistry

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## 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 (multiple choice)**

| Question Number | Correct Answer | Reject | Mark       |
|-----------------|----------------|--------|------------|
| <b>1</b>        | C              |        | <b>(1)</b> |

| Question Number | Correct Answer | Reject | Mark       |
|-----------------|----------------|--------|------------|
| <b>2(a)</b>     | B              |        | <b>(1)</b> |

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

| Question Number | Correct Answer | Reject | Mark       |
|-----------------|----------------|--------|------------|
| <b>2(c)</b>     | B              |        | <b>(1)</b> |

| Question Number | Correct Answer | Reject | Mark       |
|-----------------|----------------|--------|------------|
| <b>2(d)</b>     | A              |        | <b>(1)</b> |

| Question Number | Correct Answer | Reject | Mark       |
|-----------------|----------------|--------|------------|
| <b>3</b>        | B              |        | <b>(1)</b> |

| Question Number | Correct Answer | Reject | Mark       |
|-----------------|----------------|--------|------------|
| <b>4(a)</b>     | D              |        | <b>(1)</b> |

| Question Number | Correct Answer | Reject | Mark       |
|-----------------|----------------|--------|------------|
| <b>4(b)</b>     | A              |        | <b>(1)</b> |

| Question Number | Correct Answer | Reject | Mark       |
|-----------------|----------------|--------|------------|
| <b>4(c)</b>     | B              |        | <b>(1)</b> |

| Question Number | Correct Answer | Reject | Mark       |
|-----------------|----------------|--------|------------|
| <b>4(d)</b>     | C              |        | <b>(1)</b> |

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

| Question Number | Correct Answer | Reject | Mark       |
|-----------------|----------------|--------|------------|
| <b>6(a)</b>     | A              |        | <b>(1)</b> |

| Question Number | Correct Answer | Reject | Mark       |
|-----------------|----------------|--------|------------|
| <b>6(b)</b>     | C              |        | <b>(1)</b> |

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

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

| Question Number | Correct Answer | Reject | Mark       |
|-----------------|----------------|--------|------------|
| <b>9</b>        | C              |        | <b>(1)</b> |

| Question Number | Correct Answer | Reject | Mark       |
|-----------------|----------------|--------|------------|
| <b>10 (a)</b>   | D              |        | <b>(1)</b> |

| Question Number | Correct Answer | Reject | Mark       |
|-----------------|----------------|--------|------------|
| <b>10(b)</b>    | D              |        | <b>(1)</b> |

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

| Question Number | Correct Answer | Reject | Mark       |
|-----------------|----------------|--------|------------|
| <b>12</b>       | B              |        | <b>(1)</b> |

**Total for Section A = 20 marks**

**Section B**

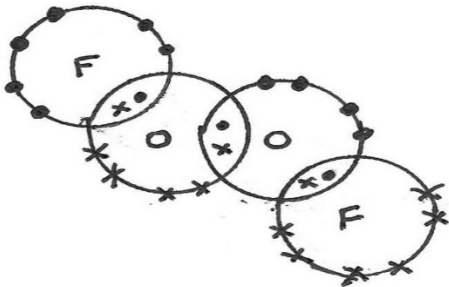
| Question Number | Acceptable Answers                                                                                                                                                    | Reject                                           | Mark        |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|-------------|
| <b>13(a)(i)</b> | Ignore drawn shapes<br><br>Shape is <b>trigonal planar/ triangular planar</b> (1)<br><br>Bond angle 120(°) (1)<br><br>Mark independently BUT no TE on incorrect shape | ...pyramidal<br><br><b>Just planar</b><br><br>°C | <b>(20)</b> |

| Question Number | Acceptable Answers                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Reject                                                                                                                    | Mark |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|------|
| *13(a)(ii)      | <p>(Shape)<br/>Ignore references to tetrahedral/pyramidal</p> <div> </div> <p><b>NOTE:</b><br/>Lone pair on central N atom NOT required<br/><b>ALLOW:</b><br/>Any correct variation as long as the shape is clear<br/>(1)</p> <p>(Bond angle) 107°<br/><b>ALLOW</b><br/>Any angle between 106° – 108°<br/><b>OR</b> 102° (as this is the actual bond angle)<br/>(1)</p> <p>Mark independently</p> <p>(Explanation)</p> <p>Minimum repulsion/maximum separation<br/>(between pairs of electrons)<br/>(1)</p> <p>Lone pair-bond pair repulsions are <b>greater/more</b> than bond pair-bond pair repulsions</p> <p><b>ALLOW</b></p> <p>Lone pair(s) <b>repel more than bond pair(s)</b><br/>(1)</p> <p>Mark independently</p> | <p>No M1 if incorrect name for shape<br/>eg<br/>bipyramidal</p> <p>...between atoms /<br/><b>Just</b><br/>bonds repel</p> | (4)  |

| Question Number   | Correct Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Reject                                                       | Mark       |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|------------|
| <b>13(a)(iii)</b> | <p><b>M1</b></p> <pre>       F  F            F — N → B — F                  F  F           </pre> <p>OR</p> <pre>       F  F            F — N — B — F                  F  F           </pre> <p>OR</p> <p>Dot and cross diagram, allow all dots or crosses.</p> <p>IGNORE omission of non-bonding electrons on Fs.</p> <p>But no mark if dot and cross shown for N-B bond.</p> <p style="text-align: right;"><b>(1)</b></p> <p><b>M2 Dative covalent</b> (bond)</p> <p style="text-align: right;"><b>(1)</b></p> <p>Mark independently</p> | <p>No M1 if dative bond <b>categorically</b> from B to N</p> | <b>(2)</b> |

| Question Number | Correct Answer                          | Reject | Mark       |
|-----------------|-----------------------------------------|--------|------------|
| <b>13(b)(i)</b> | <p>+2</p> <p><b>ALLOW</b></p> <p>2+</p> |        | <b>(1)</b> |

| Question Number  | Correct Answer                                                                                                                                                | Reject                 | Mark       |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|------------|
| <b>13(b)(ii)</b> | <p><math>\text{OF}_2 + \text{H}_2\text{O} \rightarrow 2\text{HF} + \text{O}_2</math></p> <p>Ignore state symbols even if incorrect</p> <p>Allow multiples</p> | $\text{H}_2\text{F}_2$ | <b>(1)</b> |

| Question Number | Correct Answer                                                                                                      | Reject | Mark       |
|-----------------|---------------------------------------------------------------------------------------------------------------------|--------|------------|
| <b>13(c)</b>    | Accept all dots OR all crosses<br> |        | <b>(1)</b> |

**(Total for Question 13 = 11 marks)**

| Question Number | Correct Answer                                                                                                                                                                                                                                                                              | Reject | Mark       |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------------|
| <b>14(a)(i)</b> | <p>As a (co-)solvent for both aqueous silver nitrate and bromoalkane</p> <p>OR</p> <p>As a (co-)solvent for polar and non-polar molecules</p> <p>OR</p> <p>To dissolve the halogenoalkane (as it is not water soluble)</p> <p>OR</p> <p>To allow the reagents/reactants to mix/dissolve</p> |        | <b>(1)</b> |

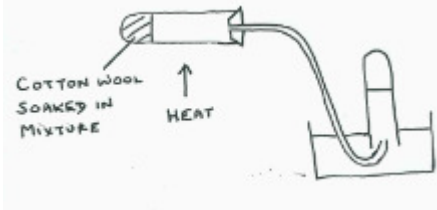
| Question Number  | Correct Answer                                                                                                                                                                                                                                                                                                                    | Reject | Mark       |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------------|
| <b>14(a)(ii)</b> | <p><math>\text{C}_4\text{H}_9\text{Br} + \text{H}_2\text{O} \rightarrow \text{C}_4\text{H}_9\text{OH} + \text{HBr}</math></p> <p>OR</p> <p><math>\text{C}_4\text{H}_9\text{Br} + \text{H}_2\text{O} \rightarrow \text{C}_4\text{H}_9\text{OH} + \text{H}^+ + \text{Br}^-</math></p> <p>Ignore state symbols even if incorrect</p> |        | <b>(1)</b> |

| Question Number   | Correct Answer                                                                                                                                                                                   | Reject                                                 | Mark       |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|------------|
| <b>14(a)(iii)</b> | <p>Cream</p> <p><b>ALLOW</b></p> <p><b>Pale</b> yellow/off-white <b>(1)</b></p> <p><math>\text{Ag}^+(\text{aq}) + \text{Br}^-(\text{aq}) \rightarrow \text{AgBr}(\text{s})</math> <b>(1)</b></p> | <p><b>Just</b> "yellow"</p> <p><b>Just</b> "white"</p> | <b>(2)</b> |

| Question Number  | Correct Answer                                                                                                                                                                | Reject | Mark       |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------------|
| <b>14(a)(iv)</b> | <b>Concentrated</b> ammonia (solution)<br>/ <b>Concentrated</b> NH <sub>3</sub> ((aq))<br><br>ALLOW 'c' or 'conc' for concentrated<br><b>IGNORE</b><br>References to "excess" |        | <b>(1)</b> |

| Question Number | Correct Answer                                                             | Reject | Mark     |
|-----------------|----------------------------------------------------------------------------|--------|----------|
| <b>14(a)(v)</b> | <b>C, B, A</b><br><br><b>NOTE</b><br><br>The letters must be in this order |        | <b>1</b> |

| Question Number   | Correct Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Reject                                                              | Mark       |
|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|------------|
| <b>*14(a)(vi)</b> | <p><b>Any two from</b></p> <ul style="list-style-type: none"> <li>• Tertiary is the fastest / primary is the slowest</li> <li>• The C-Br bond is weakest in 2-methylbromopropane / in the tertiary (compound)</li> </ul> <p>ALLOW here: The weaker the C-Br bond, the faster the hydrolysis</p> <ul style="list-style-type: none"> <li>• (This is because the) methyl groups donate electrons</li> </ul> <p>OR</p> <p>methyl groups are electron releasing</p> <p>OR</p> <p>(positive) inductive effect of methyl groups</p> <p><b>IGNORE</b></p> <p>Any resultant effect on the polarity of the C-Br bond, even if incorrect</p> <ul style="list-style-type: none"> <li>• Tertiary carbocation OR intermediate formed by tertiary is (more) stable</li> </ul> <p>ALLOW branched for tertiary in all points</p> <p><b>IGNORE</b></p> <p>Any references to steric hindrance</p> <p>Any references to S<sub>N</sub>1 and/or S<sub>N</sub>2</p> | <p>If states that tertiary bromoalkane <b>dissolves</b> fastest</p> | <b>(2)</b> |

| Question Number | Correct Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Reject | Mark       |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------------|
| <b>14(b)(i)</b> |  <p><b>M1: All three of the following points</b></p> <ul style="list-style-type: none"> <li>• (Cotton) wool / mineral wool / ceramic fibre (soaked in reactant)</li> <li>• in a reasonably horizontal test tube</li> <li>• heating (shown anywhere under horizontal tube)</li> </ul> <p style="text-align: right;"><b>(1)</b></p> <p><b>M2:</b><br/>Collection of gas over water / in a gas syringe</p> <p style="text-align: right;"><b>(1)</b></p> <p>Ignore Bunsen valve</p> <p>Mark these scoring points independently</p> |        | <b>(2)</b> |

| Question Number  | Correct Answer                                                                                                                                                                                                        | Reject                                    | Mark       |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|------------|
| <b>14(b)(ii)</b> | But-1-ene<br><br><b>ALLOW</b><br><br>1-butene<br><br><br><br><div style="text-align: right;"> <b>(1)</b><br/><br/> <b>(1)</b> </div> | Butene<br><br>Butan-1-ene<br><br>Butanene | <b>(2)</b> |

| Question Number | Correct Answer                                                                                                                                                                                                                                       | Reject                                                                            | Mark       |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|------------|
| <b>14(c)(i)</b> | (Type) substitution<br><br><div style="text-align: right;"><b>(1)</b></div><br>(Mechanism) nucleophilic<br><br><div style="text-align: right;"><b>(1)</b></div><br>Allow words in either order<br><br><b>Just</b> "S <sub>N</sub> 2" scores one mark | Elimination<br><br><br>Electrophilic / (free) radical<br><br><br>S <sub>N</sub> 1 | <b>(2)</b> |

| Question Number  | Correct Answer                        | Reject | Mark       |
|------------------|---------------------------------------|--------|------------|
| <b>14(c)(ii)</b> | Butylamine/1-aminobutane/1-butylamine |        | <b>(1)</b> |

**(Total for Question 14 = 15 marks)**

| Question Number | Correct Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Reject                   | Mark       |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|------------|
| <b>15(a)</b>    | <p><b>M1:</b><br/>The salt dissolves in <b>the</b> water (of crystallization) / the salt dissolves in (its) water of crystallization</p> <p><b>NOTE:</b><br/>For M1 it needs to be clear that the water came from the initial solid<br/>(1)</p> <p><b>M2:</b><br/>Water boils/water evaporates<br/>(1)</p> <p><b>M3:</b><br/>(Anhydrous) magnesium nitrate / <math>\text{Mg}(\text{NO}_3)_2</math> crystallizes<br/><b>OR</b><br/>(Anhydrous) magnesium nitrate / <math>\text{Mg}(\text{NO}_3)_2</math> is formed</p> <p><b>ALLOW for M3:</b><br/>(White) solid formed as the concentration becomes too high / as water is driven off</p> <p><b>OR</b><br/>Solid reforms/forms<br/>(1)</p> | Any mention of 'melt(s)' | <b>(3)</b> |

| Question Number | Correct Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Reject                               | Mark       |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|------------|
| <b>15(b)(i)</b> | <p><b>NOTE 1:</b><br/>The chemicals identified MUST correspond to the correct <b>Stage number</b></p> <p><b>NOTE 2:</b><br/>Award mark in each case for either the correct name or the correct formula. HOWEVER if both a name AND a formula are given, BOTH must be correct.</p> <p><b>Stage 5:</b><br/>Nitrogen dioxide / NO<sub>2</sub> / N<sub>2</sub>O<sub>4</sub> (is the brown gas)<br/>(1)</p> <p><b>Stage 6:</b><br/>Oxygen / O<sub>2</sub> (relights a glowing splint)<br/>(1)</p> <p><b>Stage 7:</b><br/>Magnesium oxide / MgO (is the white solid)<br/>(1)</p> | <b>Just "O" for oxygen's formula</b> | <b>(3)</b> |

| Question Number  | Correct Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Reject | Mark       |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------------|
| <b>15(b)(ii)</b> | <p>2Mg(NO<sub>3</sub>)<sub>2</sub>·6H<sub>2</sub>O → 2MgO + 4NO<sub>2</sub> + O<sub>2</sub> + 12H<sub>2</sub>O<br/>Ignore state symbols even if incorrect</p> <p><b>ALLOW</b> multiples<br/><b>ALLOW</b> 2N<sub>2</sub>O<sub>4</sub> for 4NO<sub>2</sub></p> <p><b>M1</b> Correct entities <b>(1)</b></p> <p><b>M2</b> Balancing <b>(1)</b><br/><b>M2 depends on M1</b></p> <p><b>Special case</b></p> <p>If the anhydrous salt equation is given:<br/>2Mg(NO<sub>3</sub>)<sub>2</sub> → 2MgO + 4NO<sub>2</sub> + O<sub>2</sub> scores <b>1 max</b></p> |        | <b>(2)</b> |

| Question Number | Correct Answer                                                                                                                                                                                                                                                 | Reject                                                                                   | Mark       |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|------------|
| <b>15(c)(i)</b> | (Magnesium chloride)<br>Colourless / no colour<br><div style="text-align: right;"><b>(1)</b></div><br>(Calcium chloride)<br>Yellow-red <b>OR</b> brick-red <b>OR</b> red<br><br><b>ALLOW</b><br>Orange-red<br><div style="text-align: right;"><b>(1)</b></div> | UV/white/bright white<br><br>Crimson<br><br><b>Just</b> 'orange'<br><b>Just</b> 'yellow' | <b>(2)</b> |

| Question Number   | Correct Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Reject                                                                                           | Mark       |
|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|------------|
| <b>*15(c)(ii)</b> | <b>M1 – for idea of <b>electrons</b> being promoted</b><br>(Heating) promotes <b>electrons</b> / excites <b>electrons</b> (to higher energy levels)<br><div style="text-align: right;"><b>(1)</b></div><br><b>M2 – for idea of electrons falling back down</b><br>Electrons fall back (to lower levels / ground states)<br><div style="text-align: right;"><b>(1)</b></div><br><b>M3 – for idea of emission of light</b><br>Emitting (visible) light / emitting photons<br><div style="text-align: right;"><b>(1)</b></div> | <b>Just</b> molecules gain energy<br><br><br><br><br>No M3 if mention of energy / light absorbed | <b>(3)</b> |

| Question Number   | Correct Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Reject                                            | Mark       |
|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|------------|
| <b>15(c)(iii)</b> | <p><b>M1:</b></p> <p>EITHER</p> <p>In magnesium the energy levels are further apart / the energy levels are different</p> <p>OR</p> <p>In calcium the energy levels are closer / the energy levels are different</p> <p><b>IGNORE</b></p> <p>Any comparison of the relative numbers of energy levels</p> <p><b>M2:</b></p> <p>For magnesium, the energy released is outside the visible spectrum / visible region</p> <p>OR</p> <p>For calcium, the energy released is inside the visible spectrum / visible region</p> <p>OR</p> <p>the energy released is in the red region (of the spectrum)</p> <p>OR</p> <p>Different amounts of energy are released</p> <p>OR</p> <p>Different frequencies / wavelengths emitted</p> <p style="text-align: right;"><b>(1)</b></p> <p>Mark these points independently</p> | <p><b>Just</b> "no transitions for magnesium"</p> | <b>(2)</b> |

**(Total for Question 15 = 15 marks)**

**Total for Section B = 41 marks**

## Section C

| Question Number | Correct Answer                                                            | Reject                         | Mark       |
|-----------------|---------------------------------------------------------------------------|--------------------------------|------------|
| <b>16(a)(i)</b> | <pre>       Cl H           Cl—C—C—H                 Cl H           </pre> | Skeletal / structural formulae | <b>(1)</b> |

| Question Number  | Correct Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Reject                                                             | Mark       |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|------------|
| <b>16(a)(ii)</b> | <p><b>Read the whole answer first</b></p> <p><b>Any two from</b></p> <ul style="list-style-type: none"> <li>(Higher boiling temperature) because it has stronger/more London forces</li> <li>(Because it has) more electrons (66 compared with 50)</li> </ul> <p><b>IGNORE</b></p> <p>References to larger electron cloud / higher electron density / greater <math>M_r</math> / incorrect 'counting' of electrons in either or both molecules</p> <ul style="list-style-type: none"> <li>1,1,1-trichloroethane has dipole-dipole interactions</li> <li>(Because the molecule is polar due to) polar C-Cl bonds</li> </ul> <p>OR</p> <ul style="list-style-type: none"> <li>Cl is more electronegative than C OR Cl is more electronegative than H</li> </ul> <p>OR</p> <p>Cl atoms on same side (of molecule)</p> <p>OR</p> <p>C-Cl dipoles do not cancel</p> <ul style="list-style-type: none"> <li>Hexane has <b>only</b> London forces</li> </ul> | Any reference to breaking covalent bonds scores <b>(0)</b> overall | <b>(2)</b> |

| Question Number   | Correct Answer                                                                                                                                                                                                                                                                                                                                  | Reject                                                                               | Mark       |
|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|------------|
| <b>16(a)(iii)</b> | <p>Because they damage the ozone layer</p> <p>OR</p> <p>(Halothane products like)<br/>1,1,1-trichloroethane are narcotic inhalants / poisonous / toxic</p> <p><b>IGNORE</b></p> <p>References to just:</p> <ul style="list-style-type: none"> <li>• formation of chlorine radicals</li> <li>• formation of Cl•</li> <li>• carcinogen</li> </ul> | Any statement that this compound is a CFC / forms Cl <sub>2</sub> (on breaking down) | <b>(1)</b> |

| Question Number | Correct Answer                                                                                                                                                                                                                                                                                                                                                                                                                       | Reject                                 | Mark       |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|------------|
| <b>16(b)(i)</b> | <p>ICI is a <b>stronger</b> electrophile / <b>better</b> electrophile</p> <p>Allow a correct description of an electrophile even if the term is not used.<br/>e.g. ICl has a vacancy for a bonding pair of electrons</p> <p>OR</p> <p>the ICl (bond) is polar</p> <p><b>NOTE:</b></p> <p>ALLOW the ICl (bond) is more polar</p> <p>OR</p> <p>Mention of presence of the I<sup>δ+</sup> (in ICl)</p> <p>ALLOW</p> <p>'It' for ICl</p> | Any references to Cl attacking the C=C | <b>(1)</b> |

| Question Number  | Correct Answer                                                                                                                                                                                                                                                                                                                       | Reject                      | Mark       |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|------------|
| <b>16(b)(ii)</b> | $\begin{array}{c} \text{I} \quad \text{Cl} \\   \quad   \\ \text{CH}_3(\text{CH}_2)_7 - \text{C} - \text{C} - (\text{CH}_2)_7\text{COOH} \\   \quad   \\ \text{H} \quad \text{H} \end{array}$ <p>I and Cl can be interchanged and on either side</p> <p>Look out for only I or Cl added without hydrogen, also 2I and 2Cl added.</p> | I and Cl on the same carbon | <b>(1)</b> |

| Question Number   | Correct Answer                                                                                                                                                                                                                                                                                                  | Reject                                            | Mark       |
|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|------------|
| <b>16(b)(iii)</b> | <p>To prevent formation of free radicals</p> <p>OR</p> <p>To prevent (free radical) substitution</p> <p>OR</p> <p>To prevent (I-Cl) bonds breaking homolytically</p> <p><b>ALLOW</b></p> <p><b>UV</b> causes it to react / to decompose</p> <p><b>IGNORE</b></p> <p>light causes it to react / to decompose</p> | <p>Causes oxidation</p> <p><b>C-Cl</b> breaks</p> | <b>(1)</b> |

| Question Number  | Correct Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Reject | Mark       |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------------|
| <b>16(b)(iv)</b> | <p>ALL THREE oxidation numbers must be correct:</p> <p>(Iodine monochloride) +1</p> <p>ALLOW 1+</p> <p>(Iodide ion) -1</p> <p>ALLOW 1-</p> <p>(Iodine) 0</p> <p style="text-align: right;"><b>(1)</b></p> <p>(Ionic equation)</p> $\text{ICl} + \text{I}^- \rightarrow \text{I}_2 + \text{Cl}^-$ <p>Ignore state symbols even if incorrect</p> <p>Both partial and full charges on ICl are acceptable, provided they are the right way around</p> <p style="text-align: right;"><b>(1)</b></p> |        | <b>(2)</b> |

| Question Number | Correct Answer                                                                                                                                                                                                                                                                                                                                                          | Reject                                             | Mark       |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|------------|
| <b>16(c)</b>    | <p>(Indicator)</p> <p>Starch (solution)</p> <p style="text-align: right;"><b>(1)</b></p> <p>(Colour change from)</p> <p>Blue-black to colourless</p> <p><b>ALLOW</b></p> <p>Blue to colourless</p> <p>OR</p> <p>Black to colourless</p> <p><b>IGNORE</b></p> <p>References to 'clear'</p> <p style="text-align: right;"><b>(1)</b></p> <p><b>Mark independently</b></p> | <p>No M2 if states "From <b>purple</b> to ..."</p> | <b>(2)</b> |

In 16(d) penalise incorrect units once **only**

| Question Number | Correct Answer                                                                                           | Reject | Mark       |
|-----------------|----------------------------------------------------------------------------------------------------------|--------|------------|
| <b>16(d)(i)</b> | Number of moles of thiosulfate =<br>$\frac{20.0 \times 0.100}{1000} = 2(.00) \times 10^{-3} / 0.002(00)$ |        | <b>(1)</b> |

| Question Number  | Correct Answer                                                                                                                                                  | Reject | Mark       |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------------|
| <b>16(d)(ii)</b> | $(2\text{S}_2\text{O}_3^{2-}(\text{aq}) + \text{I}_2(\text{aq}) \rightarrow \text{S}_4\text{O}_6^{2-} + 2\text{I}^-)$<br>IGNORE state symbols even if incorrect |        | <b>(1)</b> |

**ALLOW TE** in all remaining parts from the previous part(s) **Calculators needed!**

**PENALISE** rounding errors in (d)(v) to (d)(vii) **only once**

**Also** penalise 1 SF in (d)(v) to (d)(vii) **only once**

| Question Number   | Correct Answer                                                                                           | Reject | Mark       |
|-------------------|----------------------------------------------------------------------------------------------------------|--------|------------|
| <b>16(d)(iii)</b> | Number of moles of iodine<br>$= 0.002(00) \div 2$<br>$= 1(.00) \times 10^{-3} / 0.001(00) \text{ (mol)}$ |        | <b>(1)</b> |

| Question Number  | Correct Answer                                    | Reject | Mark       |
|------------------|---------------------------------------------------|--------|------------|
| <b>16(d)(iv)</b> | $1(.00) \times 10^{-3} / 0.001(00) \text{ (mol)}$ |        | <b>(1)</b> |

| Question Number | Correct Answer                                                               | Reject | Mark       |
|-----------------|------------------------------------------------------------------------------|--------|------------|
| <b>16(d)(v)</b> | $(0.001(00) - 0.000365)$<br>$= 6.35 \times 10^{-4} / 0.000635 \text{ (mol)}$ |        | <b>(1)</b> |

| Question Number  | Correct Answer                                                                                      | Reject | Mark       |
|------------------|-----------------------------------------------------------------------------------------------------|--------|------------|
| <b>16(d)(vi)</b> | $(\frac{0.000635 \times 100}{0.2(00)} \text{ OR } 0.000635 \times 500)$<br>$= 0.3175 \text{ (mol)}$ |        | <b>(1)</b> |

| Question Number   | Correct Answer                                                                                                            | Reject | Mark       |
|-------------------|---------------------------------------------------------------------------------------------------------------------------|--------|------------|
| <b>16(d)(vii)</b> | $0.3175 \times 2 \times 126.9 = 80.5815 \text{ (g)}$<br>If student uses $A_r$ for I = 127, final answer equals 80.645 (g) |        | <b>(1)</b> |

If d(iii)/(iv) is 0.002 this gives 0.001635, 0.8175 and 207.4815 for (v) to (vii)

If d(iii)/(iv) is 0.0005 this gives 0.000135, 0.0675 and 17.1315 for (v) to (vii)

| Question Number | Correct Answer                                                    | Reject | Mark     |
|-----------------|-------------------------------------------------------------------|--------|----------|
| <b>16(e)</b>    | (Sample titre)<br>Higher<br><b>and</b><br>(Iodine value)<br>Lower |        | <b>1</b> |

**(Total for Section C = 19 Marks)**

**TOTAL FOR PAPER = 80 MARKS**

