



# Mark Scheme (Results)

Summer 2014

IAL Chemistry (WCH02/01)

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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 (a)</b>	B		1

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

Question Number	Correct Answer	Reject	Mark
<b>2</b>	B		1

Question Number	Correct Answer	Reject	Mark
<b>3</b>	C		1

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

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

Question Number	Correct Answer	Reject	Mark
<b>5</b>	A		1

Question Number	Correct Answer	Reject	Mark
<b>6</b>	C		1

Question Number	Correct Answer	Reject	Mark
<b>7</b>	A		1

Question Number	Correct Answer	Reject	Mark
<b>8</b>	B		1

Question Number	Correct Answer	Reject	Mark
<b>9</b>	D		1

Question Number	Correct Answer	Reject	Mark
<b>10</b>	C		1

Question Number	Correct Answer	Reject	Mark
<b>11 (a)</b>	D		1

Question Number	Correct Answer	Reject	Mark
<b>11 (b)</b>	C		1

Question Number	Correct Answer	Reject	Mark
<b>12</b>	C		1

Question Number	Correct Answer	Reject	Mark
<b>13</b>	B		1

Question Number	Correct Answer	Reject	Mark
<b>14</b>	A		1

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

Question Number	Correct Answer	Reject	Mark
<b>16</b>	D		1

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

**TOTAL FOR SECTION A = 20 MARKS**

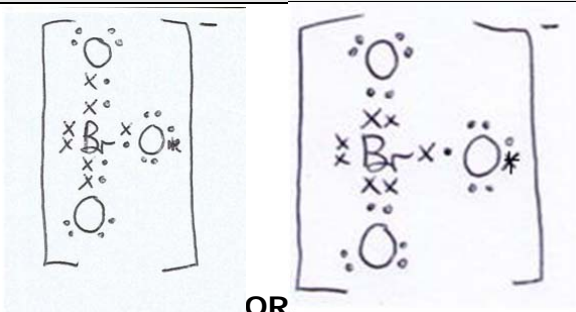
**Section B**

Question Number	Acceptable Answers	Reject	Mark
<b>18 (a)</b>	$\text{NaCl} + \text{H}_2\text{SO}_4 \rightarrow \text{HCl} + \text{NaHSO}_4$  ALLOW Multiples $\text{HNaSO}_4$  $2\text{NaCl} + \text{H}_2\text{SO}_4 \rightarrow 2\text{HCl} + \text{Na}_2\text{SO}_4$  IGNORE state symbols even if incorrect  COMMENT ALLOW Capitals or lower case in formulae		1

Question Number	Acceptable Answers	Reject	Mark
<b>18 (b)</b>	Ammonia (gas) / $\text{NH}_3$  Allow Ammonia solution/ $\text{NH}_3(\text{aq})$ <b>(1)</b>  White smoke/solid  ALLOW white cloud / <b>Dense</b> white fumes <b>(1)</b>  The observation mark is consequential on use of ammonia. If name and formula are given, both must be correct.	Ammonium  Incorrect identification of white smoke  Misty fumes / steamy fumes/ white gas/ white ppt	2

Question Number	Acceptable Answers	Reject	Mark
<b>18 (c)</b>	<p>White ppt/solid</p> <p>ALLOW white crystals (1)</p> <p>IGNORE identification of white solid, even if wrong</p> <p>(ppt/solid) dissolves (in excess) / (colourless) solution forms</p> <p>ALLOW (ppt/solid) disappears/ soluble (1)</p> <p>IGNORE clear solution</p> <p>(c.NH<sub>3</sub>) dissolves AgBr (as well as AgCl) (1)</p>	<p>Just "white" Cream ppt</p> <p>other colours of solution</p> <p>Dissolves bromide ions/ bromine Just "Only AgCl dissolves in dilute NH<sub>3</sub>" c.NH<sub>3</sub> dissolves other things</p>	3

**TOTAL FOR Q18 = 6 MARKS**

Question Number	Acceptable Answers	Reject	Mark
<b>19</b> <b>(a)(i)</b>	 <p style="text-align: center;"><b>OR</b></p> <p>7x and 5 • around the bromine. <b>(1)</b></p> <p>Total of 8 electrons round each oxygen One octet <b>MUST INCLUDE</b> the electron represented by * <b>(1)</b></p> <p><b>ALLOW</b> x for oxygen and • for bromine if clear</p> <p>Electrons in bonds to be shown in rows eg xx •• or x•x• between the relevant atoms; non-bonded electrons not in pairs..</p> <p>All dots or all crosses then max 1</p> <p>Two dative covalent bonds by the bromine to the oxygens then max 1 (loses first mark)</p> <p><b>IGNORE</b> circles round outer shells of atoms</p>		2

Question Number	Acceptable Answers	Reject	Mark
<b>19</b> <b>(a)(ii)</b>	<p>There are vacant (3)<b>d</b> orbitals / They are using (3)<b>d</b> orbitals</p> <p><b>ALLOW</b> Sub-shells for orbitals Use of D for d</p>	<p>2d p/ f orbitals</p> <p>Shell for sub-shell</p>	1

Question Number	Acceptable Answers	Reject	Mark
<b>19 (b) (i)</b>	<p><math>(n=8.35 \div 167 = ) 0.05(00) \text{ (mol)}</math> <b>(1)</b> Ignore any units even if incorrect.</p> <p><math>(c= 0.05 \div 0.25 =) 0.2(00) \text{ (mol dm}^{-3}\text{)}</math> TE on incorrect number of moles in first mark <b>(1)</b></p> <p>Correct answer without working scores <b>(2)</b> If final units are given they must be correct.</p> <p>ALLOW 1sf mol /dm<sup>3</sup> OR M</p>	mol /dm <sup>-3</sup>	2

Question Number	Acceptable Answers	Reject	Mark
<b>19 (b) (ii)</b>	<p><math>(0.0025 \times 6 = ) 0.015 \text{ (mol)}</math> <b>(1)</b></p> <p><math>(0.015 \times 166 = 2.49 \text{ (g)})</math> TE from first mark <b>(1)</b></p> <p><math>2.6 \leq \text{value} \leq 5.0 \text{ (g)}</math></p> <p>TE for third mark as long as a calculation has been done for second mark. Values should be at least 0.1 g above calculated value and less than double calculated value. <b>(1)</b></p> <p>ALLOW 1sf for suitable mass</p>		3

Question Number	Acceptable Answers	Reject	Mark
<b>19</b> <b>(b)(iii)</b>	$(0.001 \times 2 =) 0.002 / 2 \times 10^{-3} \text{ (mol)}$ <b>(1)</b> $(V = 0.002 \div 0.1 \times 1000 =) 20 \text{ (cm}^3 \text{)}$ ALLOW $0.02 \text{ dm}^3 / 0.020 \text{ dm}^3$ <b>(1)</b> If units are not in $\text{cm}^3$ they must be stated TE from incorrect number of mol Correct answer without working scores <b>(2)</b>	0.02 $0.02 \text{ dm}^{-3}$	2

Question Number	Acceptable Answers	Reject	Mark
<b>19</b> <b>(b)(iv)</b>	Mass of $\text{KBrO}_3$ <b>(1)</b> <b>Second mark depends on correct choice in first.</b> Percentage error/ uncertainty large with a small mass OR Mass is only to 1sf <b>(1)</b> IGNORE calculation, even if incorrect	Just "Mass is only to 2 decimal places" / "mass is only 0.07g" / "mass is not accurate"	2

**TOTAL FOR Q19 = 12 MARKS**

Question Number	Acceptable Answers	Reject	Mark
<b>20 *(a)</b>	<p><b>These marks are independent</b></p> <p>The outer electrons are further from the nucleus / the electron being removed is further from the nucleus/ larger atomic radius (in calcium)</p> <p>ALLOW Ca has one more shell/ more shells (of electrons) <b>(1)</b></p> <p>More shielding (in calcium) <b>(1)</b></p> <p>OR Reverse argument for magnesium</p> <p>ALLOW Discussion based on trend going down group without specifying Mg and Ca</p> <p>IGNORE repulsion between shells</p>	<p>Larger ionic radius (in Ca) Just "Calcium is larger" Reference to molecules, delocalised electrons Just "Ca has more energy levels"</p> <p>Two more shells</p> <p>Any reference to polarising power of ions</p>	2

Question Number	Acceptable Answers	Reject	Mark
<b>20 (b)</b>	Electrons are promoted/ jump / become excited to higher energy level (1)  Electron(s) return/ fall back to lower energy level  ALLOW to ground state (1)  Release of (visible ) light (energy) upon return / energy is released in visible spectrum  ALLOW release of photons upon return (1)		3

Question Number	Acceptable Answers	Reject	Mark
<b>20 (c) (i)</b>	$\text{CaO} + 2\text{HNO}_3 \rightarrow \text{Ca}(\text{NO}_3)_2 + \text{H}_2\text{O}$  Ignore state symbols even if incorrect		1

Question Number	Acceptable Answers	Reject	Mark
20 (c) (ii)	<p><b>Observation mark:</b> (Calcium nitrate) produces a <b>brown/red-brown gas</b></p> <p>ALLOW NO<sub>2</sub> for gas Fumes for gas</p> <p>OR (Potassium nitrate) does not produce a <b>brown</b> gas</p> <p>IGNORE Oxygen is given off / Gas given off relights a glowing splint (1)</p> <p><b>Second mark (can also be an observation):</b> (Only calcium nitrate) produces the oxide</p> <p>OR (Only potassium nitrate) produces the nitrite</p> <p>OR calcium nitrate is less stable to heat</p> <p>OR potassium nitrate decomposes at a higher temperature/takes longer to produce oxygen (1)</p> <p>ALLOW "Calcium nitrate produces a white solid <b>and</b> potassium nitrate produces a yellow solid" as an alternative for either mark</p> <p>NOTE Reject comparisons with one correct and one incorrect statement (this applies to both marks)</p>	<p>Flame colours</p> <p>Reference to other incorrect products.</p>	2

Question Number	Acceptable Answers	Reject	Mark
<b>20 (d) (i)</b>	Hydrogen (gas) / $H_2$ If name and formula are given both must be correct		1

Question Number	Acceptable Answers	Reject	Mark
<b>20 (d) (ii)</b>	White ppt/white solid/goes milky/goes cloudy/ white suspension <b>(1)</b>  $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$ <b>(1)</b>  ALLOW Alternative answer White precipitate forms which dissolves with excess carbon dioxide <b>(1)</b>  $Ca(OH)_2 + 2CO_2 \rightarrow Ca(HCO_3)_2$ <b>(1)</b>	White solution / any solution produced	2

Question Number	Acceptable Answers	Reject	Mark
<b>20 (d) (iii)</b>	(One of): $Sr(OH)_2/Ba(OH)_2/Ra(OH)_2$ OR (One of): Strontium/Barium/Radium hydroxide  If name and formula given then both must be correct	SrOH/ BaOH/ RaOH  Just Sr/ Ba/ Ra  $Mg(OH)_2/MgOH/$ magnesium hydroxide/ $Be(OH)_2/BeOH/$ beryllium hydroxide	1

Question Number	Acceptable Answers	Reject	Mark
<b>20 (e) (i)</b>	<p>White ppt/solid ALLOW White crystals</p> <p>(1)</p> <p>(BaSO<sub>4</sub> is insoluble but) MgSO<sub>4</sub> is (very) soluble / MgSO<sub>4</sub> gives a colourless solution/ MgSO<sub>4</sub> gives no precipitate</p> <p>ALLOW BaSO<sub>4</sub> does not dissolve</p> <p>TE on first mark if it stated that a precipitate formed even if colour is wrong/ missing</p> <p>(1)</p>	<p>White ppt of BaCl<sub>2</sub> / MgCl<sub>2</sub> Extra observations eg effervescence</p> <p>Magnesium is soluble / barium is insoluble A precipitate of magnesium sulfate forms and then dissolves Just "MgSO<sub>4</sub> is more soluble / less insoluble" Reference to solubility of chlorides There would be no reaction</p>	2

Question Number	Acceptable Answers	Reject	Mark
<b>20 (e) (ii)</b>	<p>Barium sulfate is not absorbed/ is insoluble</p> <p>IGNORE Comments on X-rays Barium sulfate is not digested Barium sulfate is unreactive/ does not react with stomach acids References to toxicity.</p>	Just 'Barium'	1

Question Number	Acceptable Answers	Reject	Mark
<b>20 (f)</b>	<p><b>First mark:</b> (Increase) concentration of <b>HCl</b> <b>(1)</b></p> <p><b>Second mark</b> More particles/ moles of (HCl) in the same volume OR more (frequent/ successful ) collisions</p> <p>Allow second mark only if factor is concentration <b>(1)</b></p> <p>-----</p> <p>Any two from three of the following for third and fourth marks:</p> <p>Reduce particle size / use powder (instead of lumps)/ use finely divided (solid) <b>(1)</b></p> <p>(Increases) surface area <b>(1)</b></p> <p>more (frequent/ successful ) collisions <b>(1)</b></p> <p>ALLOW Reverse arguments</p>	<p>Increase concentration of <math>\text{CaCO}_3</math> /HCl <b>and</b> <math>\text{CaCO}_3</math> /reactants</p> <p>Increase kinetic energy of particles</p> <p>Increase kinetic energy of particles</p>	4

Question Number	Acceptable Answers	Reject	Mark
<b>20(g)</b>	<p>Pressure only affects gaseous reactions/ there are no gaseous reactants (or products) /there is no significant volume change/ liquids are incompressible</p> <p>ALLOW pressure doesn't affect solids/ solutions</p> <p>Note: there are many possible correct ways of expressing the idea that pressure only affects rate of reactions involving gases.</p> <p>IGNORE Number of moles in reaction doesn't change</p>		1

**TOTAL FOR Q20 = 20 MARKS**  
**TOTAL FOR SECTION B = 38 MARKS**

**Section C**

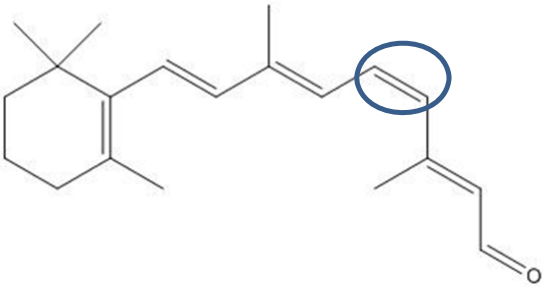
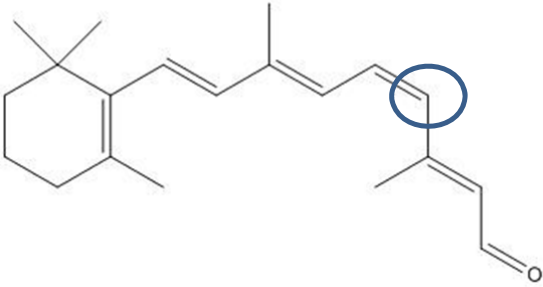
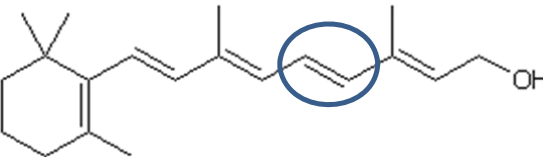
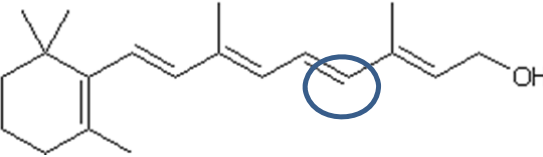
Question Number	Acceptable Answers	Reject	Mark
<b>21 (a)</b>	<p>Primary (1)</p> <p>Part of the molecule which determines how it will react / atom or group responsible for its reactions / group where chemical reactions occur/ part of the molecule responsible for its (chemical) properties</p> <p>ALLOW The part of the molecule which reacts / Group responsible for its characteristics (1)</p> <p>IGNORE Group which determines how the molecule behaves</p>	Molecule responsible for reactions	<b>2</b>

Question Number	Acceptable Answers	Reject	Mark
<b>21 (b)</b>	<p><math>C_{20}H_{30}O</math></p> <p>Correct number of carbons (1)</p> <p>Rest of formula correct (stand alone mark, even if C incorrect) (1)</p> <p>Note: <math>C_{20}H_{29}OH</math> scores first mark only</p> <p>Ignore working (structural formula) if shown as long as a molecular formula is given</p>	Just structural formula	<b>2</b>

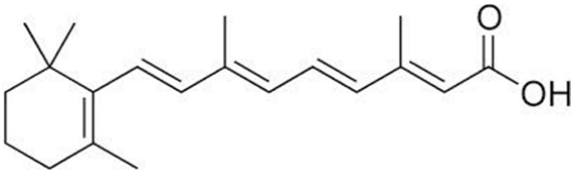
Question Number	Acceptable Answers	Reject	Mark
<b>21</b> <b>(c) (i)</b>	<p>Reflux apparatus produces carboxylic/ retinoic acid OR completely oxidizes the alcohol <b>(1)</b></p> <p>Convert to distillation</p> <p>ALLOW use condenser in horizontal position/ description of distillation/ sketch of distillation apparatus <b>(1)</b></p> <p>Oxidizing agent should be limiting/not in excess/remove aldehyde as it is formed/ remove before further oxidation <b>(1)</b></p> <p>ALLOW Use excess alcohol 'Product' for 'aldehyde'</p>	<p>Oxidizes to a ketone</p> <p>Fractional distillation</p> <p>Just 'the collection of aldehyde'</p>	<b>3</b>

Question Number	Acceptable Answers	Reject	Mark
<b>21</b> <b>(c) (ii)</b>	$\text{Cr}_2\text{O}_7^{2-}(\text{aq}) + 14\text{H}^+(\text{aq}) + 6\text{e}^- \rightarrow 2\text{Cr}^{3+}(\text{aq}) + 7\text{H}_2\text{O}(\text{l})$ <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <span>+6</span> <span>+3</span> </div> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <span>Orange</span> <span>Green</span> </div> <p style="text-align: right; margin-top: 20px;">One mark for the correct numbers of hydrogens <b>(1)</b></p> <p style="text-align: right; margin-top: 20px;">One mark for the correct numbers of chromiums and electrons <b>(1)</b></p> <p style="text-align: right; margin-top: 20px;">One mark for each oxidation number with sign. If sign is missing penalise once only ALLOW 6+ , 3+ <b>(2)</b></p> <p style="text-align: right; margin-top: 20px;">One mark for both colours <b>(1)</b></p>	Any other colour with orange/ Green-blue	5

Question Number	Acceptable Answers	Reject	Mark
<b>21</b> <b>(c) (iii)</b>	(Retinal) (strong) absorption at 1740-1720 (due to C=O bond)  OR (Retinal) (weak) absorption at 2900-2820/ 2775-2700 (due to C-H bond)  ALLOW Wavenumber/ peak/ stretch for "absorption" <b>(1)</b>  No absorption at 3750-3200 /absorption at 3750-3200 shows not all retinol converted <b>(1)</b>  Ignore comments on absorptions at 3300-2500	Absorption at 1725-1700 1700-1680	2

Question Number	Acceptable Answers	Reject	Mark
21 (c) (iv)	<p>Any one of the following:</p>   <p>ALLOW the following circles in retinol</p>  	<p>Any additional area circled</p> <p>Circles including any C atom other than those of the double bond circled on the mark scheme</p>	1

Question Number	Acceptable Answers	Reject	Mark
<b>21 (c) (v)</b>	<p>Round the carbon there are three areas with electrons / 3 regions of electron density/ 3 areas of electron density</p> <p>ALLOW Three bond pairs IF answer says that double bond can be treated as one bond (1)</p> <p>Electron pairs repel/ go to maximum separation/go to minimum repulsion (1)</p> <p>ALLOW Bonds repel</p> <p>The answer must clearly refer to electrons/ bonds/ bonding pairs at some point to score these marks.</p> <p>Trigonal planar</p> <p>ALLOW Triangular planar (1)</p>	<p>Round the carbon there are 3 bonds</p> <p>C with a lone pair</p> <p>atoms repel maximum repulsion/ minimum separation</p>	3

Question Number	Acceptable Answers	Reject	Mark
<b>21 (d)</b>	 <p>Accept any orientation of =O and -OH and length of bonds. Allow the OH displayed</p>	<p>COOH added to final single bond</p> <p>OOH added</p>	1

Question Number	Acceptable Answers	Reject	Mark
<b>21 (e)</b>	<p>Observation and precaution marks are dependent on correct reagent.</p> <p>EITHER</p> <p><b>Reagent</b>  <math>\text{PCl}_5</math> / phosphorus(V) chloride / phosphorus pentachloride  ALLOW  Phosphoric(V) chloride (1)</p> <p><b>Observation</b>  Steamy/misty/white fumes (1)</p> <p>IGNORE  Tests on steamy fumes eg litmus</p> <p><b>Precaution</b>  Use of fume cupboard (1)</p> <p>IGNORE  need for safety goggles and lab coats.  Incorrect reasons given for use of fume cupboard.  Need for dry equipment  Use of gloves</p> <p><b>OR ALLOW</b>  <b>Reagent</b>  Sodium/ Na (1)</p> <p><b>Observation</b>  Fizzing/Bubbles (1)</p> <p>IGNORE  sodium dissolves</p> <p><b>Precaution</b>  Handle with gloves/tweezers (1)</p> <p>IGNORE  naked flames  need for dry equipment  need for safety goggles and lab coats.</p>	<p>White smoke/solid Dense white fumes</p> <p>Gas mask</p>	3

**TOTAL FOR SECTION C (Question 21) = 22 MARKS**

**TOTAL FOR PAPER = 80 MARKS**

**Appendix A:****Question 19ai: Additional Guidance.**

Dot and Cross Diagram	Bonding Diagram	Score
		1
		1
		1
		2 (As per MS)

