



# Mark Scheme (Results)

January 2018

Pearson Edexcel International Advanced  
Level In Chemistry (WCH02) Paper 01  
Applications 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.

### Section A (multiple choice)

Question Number	Correct Answer	Mark
1	<b>The only correct answer is D</b> <i>A is not correct because this is linear</i> <i>B is not correct because this is trigonal planar</i> <i>C is not correct because this is tetrahedral</i>	(1)

Question Number	Correct Answer	Mark
2	<b>The only correct answer is B</b> <i>A is not correct because 90° is not in methanol</i> <i>C is not correct because 180° is not in methanol</i> <i>D is not correct because Neither bond angle in methanol</i>	(1)

Question Number	Correct Answer	Mark
3(a)	<b>The only correct answer is C</b> <i>A is not correct because all have boiling temperature below water</i> <i>B is not correct because all have boiling temperature below water</i> <i>D is not correct because all have boiling temperature below water</i>	(1)

Question Number	Correct Answer	Mark
3(b)	<b>The only correct answer is D</b> <i>A is not correct because all have weaker hydrogen bonds than hydrogen fluoride</i> <i>B is not correct because all have weaker hydrogen bonds than hydrogen fluoride</i> <i>C is not correct because all have weaker hydrogen bonds than hydrogen fluoride</i>	(1)

Question Number	Correct Answer	Mark
<b>4</b>	<p><b>The only correct answer is D</b></p> <p><i>A is not correct because both decrease</i></p> <p><i>B is not correct because ionization energy decreases</i></p> <p><i>C is not correct because solubility decreases</i></p>	<b>(1)</b>

Question Number	Correct Answer	Mark
<b>5</b>	<p><b>The only correct answer is D</b></p> <p><i>A is not correct because only Mg has correct colour</i></p> <p><i>B is not correct because no correct colours</i></p> <p><i>C is not correct because Mg and Ba have incorrect colour</i></p>	<b>(1)</b>

Question Number	Correct Answer	Mark
<b>6</b>	<p><b>The only correct answer is B</b></p> <p><i>A is not correct because are incorrect because all give nitrogen dioxide</i></p> <p><i>C is not correct because incorrect because all give nitrogen dioxide</i></p> <p><i>D is not correct because incorrect because all give nitrogen dioxide</i></p>	<b>(1)</b>

Question Number	Correct Answer	Mark
<b>7</b>	<p><b>The only correct answer is B</b></p> <p><i>A is not correct because chlorine does not give a brown solution in hexane</i></p> <p><i>C is not correct because iodine is a grey/silver solid</i></p> <p><i>D is not correct because it does not give a brown solution in hexane</i></p>	<b>(1)</b>

Question Number	Correct Answer	Mark
<b>8</b>	<p><b>The only correct answer is C</b></p> <p><i>A is not correct because give other products</i></p> <p><i>B is not correct because give other products</i></p> <p><i>D is not correct because give other products</i></p>	<b>(1)</b>

Question Number	Correct Answer	Mark
<b>9</b>	<p><b>The only correct answer is C</b></p> <p><i>A is not correct because hydrogen sulfide is not formed</i></p> <p><i>B is not correct because sulfur is not formed</i></p> <p><i>D is not correct because this is not an reduction</i></p>	<b>(1)</b>

Question Number	Correct Answer	Mark
<b>10</b>	<p><b>The only correct answer is D</b></p> <p><i>A is not correct because all have lower mean concentrations</i></p> <p><i>B is not correct because all have lower mean concentrations</i></p> <p><i>C is not correct because all have lower mean concentrations</i></p>	<b>(1)</b>

Question Number	Correct Answer	Mark
<b>11</b>	<p><b>The only correct answer is A</b></p> <p><i>B is not correct because ion-ion does not make a solution</i></p> <p><i>C is not correct because there is only a dipole in water</i></p> <p><i>D is not correct because there is only hydrogen bonding in water</i></p>	<b>(1)</b>

Question Number	Correct Answer	Mark
12	<p><b>The only correct answer is A</b></p> <p><i>B is not correct because stream is diverted</i></p> <p><i>C is not correct because it is insoluble</i></p> <p><i>D is is not correct because both statements are incorrect</i></p>	(1)

Question Number	Correct Answer	Mark
13	<p><b>13. The only correct answer is C</b></p> <p><i>A is not correct because they are too few products</i></p> <p><i>B is not correct because they are too few products</i></p> <p><i>D is not correct because this is too many products</i></p>	(1)

Question Number	Correct Answer	Mark
14	<p><b>The only correct answer is A</b></p> <p><i>B is not correct because 2-methylpropan-2-ol does not give this peak</i></p> <p><i>C is not correct because 2-methylpropan-2-ol does not give this peak</i></p> <p><i>D is not correct because neither give this peak</i></p>	(1)

Question Number	Correct Answer	Mark
15	<p><b>The only correct answer is C</b></p> <p><i>A is not correct because there is no OH absorption</i></p> <p><i>B is not correct because there is no OH absorption</i></p> <p><i>D is not correct because ketone does not contain aldehyde C-H absorptions</i></p>	(1)

Question Number	Correct Answer	Mark
<b>16</b>	<p><b>The only correct answer is B</b></p> <p><i>A is not correct because secondary alcohols oxidize to ketones</i></p> <p><i>C is not correct because secondary alcohols oxidize to ketones</i></p> <p><i>D is not correct because secondary alcohols oxidize to ketones</i></p>	<b>(1)</b>

Question Number	Correct Answer	Mark
<b>17</b>	<p><b>The only correct answer is C</b></p> <p><i>A is not correct because both are oxidized</i></p> <p><i>B is not correct because both are oxidized</i></p> <p><i>D is not correct because ketones do not react with sodium</i></p>	<b>(1)</b>

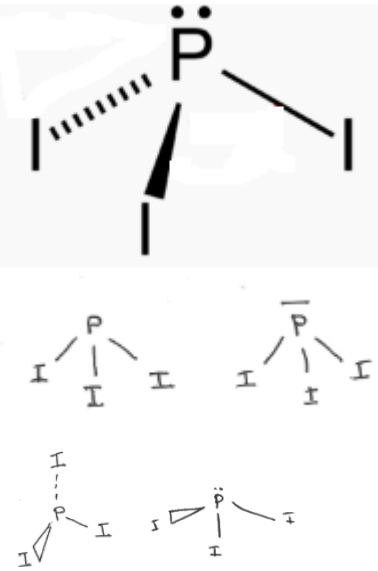
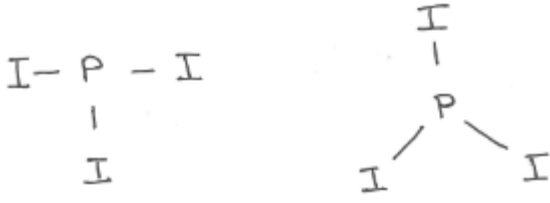
Question Number	Correct Answer	Mark
<b>18</b>	<p><b>The only correct answer is D</b></p> <p><i>A is not correct because it has carbon footprints in production or delivery</i></p> <p><i>B is not correct because it has carbon footprints in production or delivery</i></p> <p><i>C is not correct because it has carbon footprints in production or delivery</i></p>	<b>(1)</b>

Question Number	Correct Answer	Mark
<b>19</b>	<p><b>The only correct answer is A</b></p> <p><i>B is not correct because it then goes paler</i></p> <p><i>C is not correct because it initially goes darker</i></p> <p><i>D is not correct because it is the wrong way round</i></p>	<b>(1)</b>

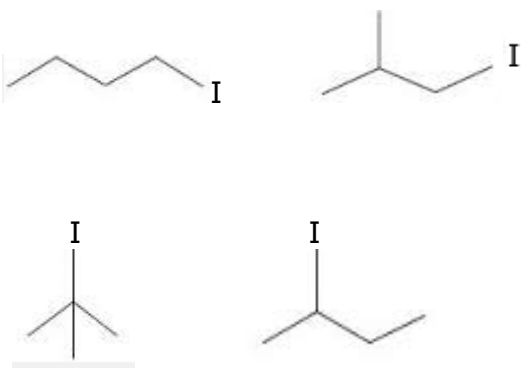
**(Total for Section A = 20 marks)**



Section B

Question Number	Acceptable Answers	Reject	Mark
*20(a)(i)	<p><b>M1</b> These are all OK:</p>  <p>These are not OK, but they can score if (trigonal) pyramidal or tetrahedral is mentioned in text:</p>  <p><b>ALLOW</b> A diagram without lone pair (1)</p> <p><b>M2</b> Bond angle in the range 106 – 108°  <b>ALLOW</b>          (Actual value is) 102° (1)</p> <p><b>M3</b> Minimum repulsion between <b>electron</b> pairs (and lone pair of electrons)  <b>ALLOW</b>          maximum separation between <b>electron</b> pairs (1)</p> <p><b>M4</b> Non-bonding/lone pairs (of electrons) repel <b>more</b> than bonding pairs (1)</p>	<p>Use of Cl or Br loses M1 only</p>	<p>(4)</p>

Question Number	Acceptable Answers	Reject	Mark
<b>20(a)(ii)</b>	$3\text{C}_4\text{H}_9\text{OH} + \text{PI}_3 \rightarrow 3\text{C}_4\text{H}_9\text{I} + \text{H}_3\text{PO}_3$ ALLOW P(OH) <sub>3</sub> for H <sub>3</sub> PO <sub>3</sub> IGNORE state symbols, even if incorrect		<b>(1)</b>

Question Number	Correct Answer	Reject	Mark
<b>20(a)(iii)</b>	<p><b>COMMENT</b></p> <p>First check for four bonds.</p> <p>Many will give two 2-iodobutane structures</p>  <p>ALLOW bonds of different lengths and strange bond angles</p> <p>2/3 correct (1)</p> <p>All 4 correct (2)</p> <p>All four fully correct displayed/structural formulae (1)</p>		<b>(2)</b>

Question Number	Correct Answer	Reject	Mark
<b>20(b)(i)</b>	(Attacking reagent) water/H <sub>2</sub> O (1) IGNORE Hydroxide/OH <sup>-</sup>  (Type and mechanism) Nucleophilic substitution  ALLOW  these words in any order and anywhere (1)  IGNORE SN1 and SN2		<b>(2)</b>

Question Number	Correct Answer	Reject	Mark
<b>20(b)(ii)</b>	Ag <sup>+</sup> (aq) + I <sup>-</sup> (aq) → AgI(s)  ALLOW  "alc" or "ethanol" for "aq"  IGNORE  Charges on ions in product.	Any other additional ions	<b>(1)</b>

Question Number	Correct Answer	Reject	Mark
<b>20(c)</b>	(1-)aminobutane/(1-)butylamine/C <sub>4</sub> H <sub>9</sub> NH <sub>2</sub>  ALLOW  1- anywhere OR Butan(e)(-1-)amine  OR  Multisubstituted amines, e.g. (C <sub>4</sub> H <sub>9</sub> ) <sub>2</sub> NH (1)  Ammonium iodide/NH <sub>4</sub> I (1)  IGNORE  Hydrogen iodide/HI  If both names and formulae are given, both must be correct.		<b>(2)</b>

**(Total for Question 20 = 12 marks)**

Question Number	Correct Answer	Reject	Mark
21(a)	<p><b>M1</b> Correct directions</p> <p>The equilibrium will move to/favours the right/forward when the temperature is increased <b>and</b> will be unchanged when the pressure is increased (1)</p> <p><b>M2</b> Temperature: because the reaction is <b>endothermic</b></p> <p>OR</p> <p><math>\Delta H</math> is positive</p> <p>OR</p> <p>Reverse reaction is exothermic /<math>\Delta H</math> is negative (1)</p> <p><b>M3</b> Pressure: there are the same number of (gaseous) molecules/moles/particles on each side of the equation (1)</p> <p>Mark independently</p>	...volumes ...alone	(3)

Question Number	Correct Answer	Reject	Mark
21(b)(i)	<p>Nitrogen from -3 to +2 (1)</p> <p>Oxygen from 0 to -2 (1)</p> <p>Elements can be named in either order but numbers must be correct for the element</p> <p>ALLOW signs on the right side</p>		(2)

Question Number	Correct Answer	Reject	Mark
<b>21 (b) (ii)</b>	<p>Increasing temperature increases the proportion/number of molecules/particles (colliding) with energy greater than the <b>activation energy/E<sub>a</sub></b>.</p> <p>OR</p> <p>Area under the Maxwell Boltzmann graph to the right of <b>activation energy/E<sub>a</sub></b> increases</p> <p>IGNORE</p> <p>High temperature results in more (effective) collisions</p>		<b>(1)</b>

Question Number	Correct Answer	Reject	Mark
<b>21 (b) (iii)</b>	<p>A catalyst reduces the activation energy (so a greater proportion of molecules have sufficient energy to react.)</p> <p>ALLOW</p> <p>In the graph the activation energy moves to the left</p> <p>IGNORE</p> <p>More collisions between particles / frequency of collisions increases</p>	Any reference to energy increasing	<b>(1)</b>

Question Number	Correct Answer	Reject	Mark
21(c)(i)	<p><b>M1</b> A nitrogen monoxide molecule changes its dipole moment as it vibrates / vibrating dipole</p> <p>ALLOW</p> <p>NO is polar/contains polar bonds (1)</p> <p><b>Then any two of M2, M3 or M4</b></p> <p><b>M2</b> NO allows through higher energy/frequency OR longer wavelength, radiation (from the sun) (1)</p> <p>OR</p> <p><b>M3</b> NO absorbs (reflected) (longer wavelength/higher frequency) <b>IR</b> (1)</p> <p>OR</p> <p><b>M4</b> NO re-emits/reflects IR/heat/radiation back to earth</p> <p>OR</p> <p>traps IR/heat/radiation (1)</p> <p>IGNORE NO reacts with the ozone layer or any reference to the ozone layer</p>	<p>...IR from sun loses M3 only</p>	<b>(3)</b>

Question Number	Correct Answer	Reject	Mark
<b>21(c)(ii)</b>	$\text{NO}\cdot + \text{O}_3 \rightarrow \text{NO}_2\cdot + \text{O}_2 \quad (1)$ $\text{NO}_2\cdot + \text{O}_3 \rightarrow \text{NO}\cdot + 2\text{O}_2 \quad (1)$ <p>Omitting all dots 1 max of first two marks</p> <p><b>BUT ALLOW</b> if one dot shown on both NO <b>and</b> NO<sub>2</sub> in either equation</p> $2\text{O}_3 \rightarrow 3\text{O}_2 \quad (1)$ <p>IGNORE state symbols, even if incorrect</p>		<b>(3)</b>

**(Total for Question 21 = 13 marks)**

Question Number	Correct Answer	Reject	Mark
<b>22(a)(i)</b>	$3\text{I}_2 + 6\text{KOH} \rightarrow \text{KIO}_3 + 5\text{KI} + 3\text{H}_2\text{O}$ <p>Balancing numbers as shown, 3 and 5 for iodine (1)</p> <p>Balancing for oxygen and hydrogen, 6KOH and 3H<sub>2</sub>O (1)</p> <p>ALLOW</p> <p>multiples</p> <p>IGNORE</p> <p>state symbols, even if incorrect</p>		<b>(2)</b>

Question Number	Correct Answer	Reject	Mark
<b>22(a)(ii)</b>	<p>Disproportionation (reaction)</p> <p>IGNORE</p> <p>redox</p>	Disproportion(al) alone	<b>(1)</b>

Question Number	Correct Answer	Reject	Mark
<b>22(b)</b>	The mixture turns (pale) yellow/brown	<p>Fizzing</p> <p>Dark brown /red-brown/ grey/grey solid/ purple vapour/ precipitate/ any solid</p>	<b>(1)</b>



Question Number	Correct Answer	Reject	Mark
<b>22(c)</b>	<p>(Both salts are soluble in hot water.)</p> <p>Potassium iodate(V) is (much) less soluble (than potassium iodide in cold water).</p> <p>ALLOW</p> <p>Potassium iodate is not soluble (in cold water)</p> <p>OR</p> <p>Potassium iodide is (more) soluble</p> <p>OR</p> <p>Solubility difference between potassium iodate and potassium iodide</p>		<b>(1)</b>

Question Number	Correct Answer	Reject	Mark
<b>22(d)(i)</b>	<p>Second mark depends on the first mark</p> <p>(Freshly prepared) starch (solution) (1)</p> <p>Added when (solution is) <b>pale</b> yellow/straw coloured</p> <p>OR</p> <p>Added when solution is <b>pale</b></p> <p>ALLOW</p> <p>Added <b>just before/ near</b> the end-point/ end of reaction/ titration/ experiment (1)</p>	<b>At the end-point etc</b>	<b>(2)</b>

Question Number	Correct Answer	Reject	Mark
<b>22(d)(ii)</b>	blue/black to colourless	...to clear	<b>(1)</b>

**ALLOW TE from d (iii) to (iv), to (v), to (vi)**

Question Number	Correct Answer	Reject	Mark
<b>22(d)(iii)</b>	$\frac{27.45 \times 0.010}{1000} = 2.745 \times 10^{-4} \text{ (mol)}$		<b>(1)</b>

Question Number	Correct Answer	Reject	Mark
<b>22(d)(iv)</b>	$\frac{2.745 \times 10^{-4}}{6} = 4.575 \times 10^{-5}$ COMMENT Multiplying by 6 gives $1.647 \times 10^{-3}$		<b>(1)</b>

Question Number	Correct Answer	Reject	Mark
<b>22(d)(v)</b>	Correct answer (with or without working) (3)  Molar mass $\text{KIO}_3 = 214.0 \text{ g mol}^{-1}$ (1)  $4.575 \times 10^{-5} \times 10 \times 214 = 0.0979(05) \text{ (g) / } 97.9 \text{ mg}$ (1) (1) IGNORE SF except 1SF  TE from $\times 6$ in (iv) gives 3.5246 (g)  Internal TE if oxygen omitted from molar mass giving 166, gives 0.075945, scores 2 marks AND Failure to multiply by 10 gives 0.00979(05)		<b>(3)</b>

Question Number	Correct Answer	Reject	Mark
<b>22(d)(vi)</b>	$\frac{0.0979(05) \times 100}{0.10} = 97.905 = 98\%$ Expression (1) 2 SF (1)  <b>Example TE</b>  166 gives 76%  Failure to multiply by 10 gives 9.8%  If expression is reversed or incorrect in any other way, give 1 max for their correct answer to 2 SF. Comment Percentages greater than 100 are allowed for 2 marks		<b>(2)</b>

Question Number	Correct Answer	Reject	Mark
<b>22(d)(vii)</b>	Potassium iodate may contain potassium iodide/ water  ALLOW  Absorption of water / hydrated (crystals)  Iodine  IGNORE  Impurities/transfer errors	Potassium hydroxide	<b>(1)</b>

(Total for Question 22 = 16 marks)  
 (Total for Section B = 41 marks)

Question Number	Correct Answer	Reject	Mark
*23(a)(i)	<p><b>Mark independently</b></p> <p><b>M1</b> London/dispersion/van der Waals forces</p> <p>OR Instantaneous/temporary dipole induced dipole forces (1)</p> <p><b>M2</b> all atoms</p> <p>OR C and H atoms / C and C atoms / H and H atoms OR non-polar parts of the molecule (1)</p> <p><b>M3</b> <b>Permanent</b> dipole (permanent) dipole forces (1)</p> <p><b>M4</b> Between C<sup>(δ+)</sup> and O<sup>(δ-)</sup> / H<sup>(δ+)</sup> and O<sup>(δ-)</sup> (atoms)</p> <p>OR Between C-O bonds OR Between O-H bonds OR CO bond / C-O is polar OR OH bond / O-H is polar (1)</p> <p><b>M5</b> Hydrogen <b>bonds</b> (1)</p> <p><b>M6</b> Between hydrogen of OH / H<sup>δ+</sup> and another oxygen</p> <p>OR Between OH groups OR Because hydrogen is bonded to very electronegative element / is bonded to oxygen (1)</p> <p>If confusion between intermolecular and intramolecular bonds award 5 max, so two points 1 mark, three points two marks etc.</p>	<p>Between bonds</p> <p>C-H is polar</p> <p>Between OH molecules/atoms</p>	(6)

Question Number	Correct Answer	Reject	Mark
<b>23(a)(ii)</b>	<p><b>Any two of the following</b></p> <p><b>M1</b> Glucose/it forms hydrogen bonds <b>with water</b> (molecules) (1)</p> <p><b>M2</b> The <b>large number</b> of O-H groups / hydroxy(l) groups</p> <p>OR</p> <p>large number of hydrogen bonds (with water)</p> <p>ALLOW</p> <p>several/five/any number greater than five /many for 'large' number (1)</p> <p><b>M3</b> Energy arguments like: Energy released by forming new hydrogen bonds makes up for energy used in breaking hydrogen bonds in water and/or glucose (1)</p> <p>IGNORE</p> <p>glucose forms London forces with water</p>	<p>...hydroxide</p> <p>Glucose is non-polar</p>	<b>(2)</b>

Question Number	Correct Answer	Reject	Mark
<b>23(b)</b>	<p><math>(C_6H_{12}O_6 \rightarrow ) 2C_2H_5OH + 2CO_2</math></p> <p>ALLOW</p> <p>Multiples</p> <p>OR</p> <p><math>C_2H_6O</math> for ethanol</p> <p>IGNORE state symbols, even if incorrect</p>		<b>(1)</b>

Question Number	Correct Answer	Reject	Mark
<b>23(c)</b>	<p><b>Any two from:</b></p> <p>Taxation of alcohol is acceptable to the public (as they can choose whether or not to drink alcohol) (1)</p> <p>(Expense may) reduce alcohol abuse (1)</p> <p>(Expense may) reduce alcohol use/consumption (1)</p> <p>Raises money for the government (1)</p> <p>Tax can be used to pay for treatment for alcohol related diseases (1)</p> <p>Alcohol is harmful/causes disease/disorders (1)</p> <p>Reduces road accidents (1)</p> <p>Detailed argument leading to less global warming (1)</p>		<b>(2)</b>

Question Number	Correct Answer	Reject	Mark
<b>23(d)(i)</b>	$\frac{100 \times 100}{57.15} = 174.9781 = 175^{(o)}$ <p>Ignore SF except 1 or 2</p>		<b>(1)</b>

Question Number	Correct Answer	Reject	Mark
23(d)(ii)	<p><b>Correct answer with or without working</b> 9.8(02)</p> <p>Ignore SF unless 1SF, Ignore units unless incorrect <b>3 marks</b></p> <p>Otherwise any <b>two</b> in any order from:</p> <p><b>M1</b> Mass of ethanol = <math>57.15 \times 0.789</math> (= 45.09)(g) (1)</p> <p><b>M2</b> Number of moles of ethanol = <math>\frac{57.15 \times 0.789}{46}</math> = (0.98025)</p> <p>ALLOW any number divided by 46 (1)</p> <p><b>M3</b> Concentration of ethanol = <math>\frac{57.15 \times 0.789 \times 1000}{46 \times 100}</math> = 9.8(025) (mol dm<sup>-3</sup>)</p> <p>ALLOW Multiplication of any number by 10 (1)</p>		(3)

Question Number	Correct Answer	Reject	Mark
23(e)	<p>Potassium nitrate is (very) soluble in water/dissolves in water.</p> <p>OR</p> <p>The potassium nitrate does not dissolve if there is a low enough concentration of water that the powder still ignites.</p> <p>OR</p> <p>The alcohol burns giving out sufficient heat to drive of a limited amount of water.</p> <p>ALLOW Any reference to the need to keep gunpowder dry</p>		(1)

Question Number	Correct Answer	Reject	Mark
<b>23(f)</b>	$2\text{KNO}_3(\text{s}) + \text{S}(\text{s}) + 3\text{C}(\text{s}) \rightarrow \text{K}_2\text{S} + \text{N}_2(\text{g}) + 3\text{CO}_2(\text{g})$  ALLOW Multiples		<b>(1)</b>

Question Number	Correct Answer	Reject	Mark
<b>23(g)</b>	$\text{C}_2\text{H}_4(\text{g}) + \text{H}_2\text{O}(\text{g}) \rightarrow \text{C}_2\text{H}_5\text{OH}(\text{aq})$  ALLOW No states, or <b>any</b> states except solid (1)  Conditions (which may be over the arrow in the equation) – any <b>one</b> from:  High temperature / any specified temperature above 25°C / heat  High pressure / pressure greater than 1 atmosphere  Catalyst / a specified catalytic substance eg Pt / Ni / sulfuric acid (phosphoric acid is used normally) (1)  Mark independently	Reflux	<b>(2)</b>

**(Total for Section C = 19 marks)**  
**(Total for Paper = 80 marks)**