



National  
Qualifications  
2018

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# **2018 Chemistry**

## **Advanced Higher**

### **Finalised Marking Instructions**

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## General Marking Principles for Advanced Higher Chemistry

*This information is provided to help you understand the general principles you must apply when marking candidate responses to questions in this paper. These principles must be read in conjunction with the detailed marking instructions, which identify the key features required in candidate responses.*

- (a) Marks for each candidate response must always be assigned in line with these General Marking Principles and the Detailed Marking Instructions for this assessment.
- (b) Marking should always be positive. This means that, for each candidate response, marks are accumulated for the demonstration of relevant skills, knowledge and understanding: they are not deducted from a maximum on the basis of errors or omissions.
- (c) If a specific candidate response does not seem to be covered by either the principles or detailed Marking Instructions, and you are uncertain how to assess it, you must seek guidance from your Team Leader.
- (d) Half marks may not be awarded.
- (e) Where a candidate makes an error at an early stage in a multi stage calculation, credit should normally be given for correct follow on working in subsequent stages, unless the error significantly reduces the complexity of the remaining stages. The same principle should be applied in questions which require several stages of non-mathematical reasoning. The exception to this rule is where the marking instructions for a numerical question assign separate “concept marks” and an “arithmetic mark”. In such situations, the marking instructions will give clear guidance on the assignment of partial marks.
- (f) Larger mark allocations may be fully accessed whether responses are provided in continuous prose, linked statements or a series of developed bullet points.
- (g) In many cases, marks can still be awarded for inaccurate or unconventional spelling or vocabulary as long as the meaning of the word(s) is conveyed. **For example**, responses that include ‘distilling’ for ‘distillation’, or ‘it gets hotter’ for ‘the temperature rises’, should be accepted. Exceptions to this rule will be given in the Additional Guidance column of the Detailed Marking Instructions.
- (h) If a correct answer and a wrong answer are present, it should be treated as a cancelling error and no marks should be given. **For example**, in response to the question, ‘State the colour seen when blue Fehling’s solution is warmed with an aldehyde’, the answer ‘red green’ gains no marks.  
However, if a correct answer and additional information, which does not conflict, are present, the additional information should be ignored, whether correct or not. **For example**, in response to a question concerned with melting point, ‘State why the tube should not be made of copper’, the response ‘Copper has a low melting point and is coloured grey’ would **not** be treated as having a cancelling error.
- (i) Full marks are usually awarded for the correct answer to a calculation without working and the partial marks shown in the Detailed Marking Instructions are for use when working is given but the final answer is incorrect. An exception is when candidates are asked to ‘Find, by calculation’, when full marks cannot be awarded for the correct answer without working.
- (j) Significant figures.  
If the data in a question is given to three significant figures, the final answer should also have three significant figures. However one less significant figure and up to two more significant figures is acceptable.

For example if a correct final answer is 8.16 J then 8.2 J, 8.158 J and 8.1576 J would also be acceptable. Answers out with this range would not be acceptable and one mark would not be awarded.

This marking instruction must only be applied a maximum of once per paper and cannot be applied if instruction (k) has already been applied in the paper.

**(k) Units**

In most questions units are not required. However, if the candidate writes units then they must be correct.

An incorrect unit would not be acceptable and one mark would not be awarded.

This marking instruction must only be applied a maximum of once per paper and cannot be applied if instruction (j) has already been applied in the paper.

**(l) Intermediate rounding.**

Ideally, calculated intermediate values should not be rounded. However if the candidate has rounded, the calculated intermediate values can have one significant figure less than the data given in the question but no fewer.

For example, if the data in a question is given to three significant figures, the intermediate value should have no fewer than two significant figure.

**(m) Ignore the omission of one H atom from a full structural formula provided the bond is shown or the omission of one bond provided the attached H atom is shown.**

**(n) If a structural formula is asked for, CH<sub>3</sub> and CH<sub>3</sub>CH<sub>2</sub> are acceptable as methyl and ethyl groups respectively.**

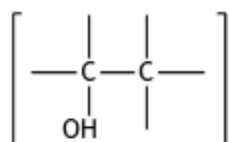
If a name is asked for such as 3-methylhexane, then 3,methyl-hexane would be acceptable, i.e. ignore incorrect use of commas and dashes.

**(o) With structures involving an -OH or an -NH<sub>2</sub> group, a mark should only be awarded if the "O" or "N" are bonded to a carbon, i.e. not OH-CH<sub>2</sub> and NH<sub>2</sub>-CH<sub>2</sub>.**

When drawing structural formulae, a mark should only be awarded if the bond points to the "correct" atom.

This marking instruction must only be applied a maximum of once per question.

The example below would be incorrect.



**(p) A symbol or correct formula should be accepted in place of a name unless stated otherwise in the Detailed Marking Instructions.**

**(q) When formulae of ionic compounds are given as answers it will only be necessary to show ion charges if these have been specifically asked for. However, if ion charges are shown, they must all be included and be correct. If incorrect charges are shown, no marks should be awarded.**

**(r) If an answer comes directly from the text of the question, no marks should be given. For example, in response to the question, 'A student found that 0.05 mol of propane, C<sub>3</sub>H<sub>8</sub> burned to give 82.4 kJ of energy. C<sub>3</sub>H<sub>8</sub>(g) + 5O<sub>2</sub>(g) → 3CO<sub>2</sub>(g) + 4H<sub>2</sub>O(l).' Name the kind of enthalpy change that the student measured', no marks should be given for "burning" since the word "burned" appears in the text.**

- (s) A guiding principle in marking is to give credit for correct elements of a response rather than to look for reasons not to give marks.
- (t) Marks are awarded only for a valid response to the question asked. For example, in response to questions that ask candidates to:
- **compare**, they must demonstrate knowledge and understanding of the similarities and/or differences between things;
  - **complete**, they must finish a chemical equation or fill in a table with information
  - **describe**, they must provide a statement or structure of characteristics and/or features;
  - **determine** or **calculate**, they must determine a number from given facts, figures or information;
  - **draw**, they must draw a diagram or structural formula, eg “Draw a diagram to show the part of a poly(propene) molecule formed from two propene molecules”
  - **estimate**, they must determine an approximate value for something;
  - **evaluate**, they must make a judgement based on criteria;
  - **explain**, they must relate cause and effect and/or make relationships between things clear;
  - **identify, name, give or state**, they need only name or present in brief form;
  - **predict**, they must suggest what may happen based on available information;
  - **suggest**, they must apply their knowledge and understanding of chemistry to a new situation. A number of responses are acceptable; marks will be awarded for any suggestions that are supported by knowledge and understanding of chemistry;
  - **use your knowledge of chemistry to comment on**, they must apply their skills, knowledge and understanding to respond appropriately to the problem/situation presented (for example by making a statement of principle(s) involved and/or a relationship or equation, and applying these to respond to the problem/situation). They will be rewarded for the breadth and/or depth of their conceptual understanding.
  - **write**, they must complete a chemical or word equation, e.g. “Write the word equation for the complete combustion of ethanol.”

## Detailed marking instructions for each question

### Section 1

Question	Answer	Max mark
1.	A	1
2.	D	1
3.	A	1
4.	D	1
5.	B	1
6.	C	1
7.	A	1
8.	D	1
9.	B	1
10.	C	1
11.	D	1
12.	B	1
13.	D	1
14.	B	1
15.	B	1
16.	C	1
17.	A	1
18.	A	1
19.	C	1
20.	B	1
21.	C	1
22.	C	1
23.	A	1
24.	B	1
25.	B	1
26.	D	1
27.	B	1
28.	C	1
29.	D	1
30.	C	1

## Section 2

Question			Expected response	Max mark	Additional guidance
1.	(a)	(i)	sodium/Na	1	
		(ii)	425 (nm) (2)  Partial Marking  One mark can be awarded for:  correct equation(s)/substitution  OR  $4.25 \times 10^{-7}$ m on its own.	2	430/424.6/424.60 are also acceptable answers.  General marking instruction (l) applies.  Units not required, but if included must be correct.
		(iii)	87 (mg kg <sup>-1</sup> )	1	90 is also an acceptable answer.  Units not required, but if included must be correct.
	(b)	(i)	Orbitals/shells/subshells/(energy) levels are filled in order of increasing energy.	1	The candidate must state what is being filled and so answers such as, 'electrons fill with increasing energy' would not be acceptable.
		(ii)	3,1,-1, (+) <sup>1</sup> / <sub>2</sub> OR 3,1,-1, - <sup>1</sup> / <sub>2</sub>  OR  3,1, 0, (+) <sup>1</sup> / <sub>2</sub> OR 3,1, 0, - <sup>1</sup> / <sub>2</sub>  OR  3,1,1, (+) <sup>1</sup> / <sub>2</sub> OR 3,1,1, - <sup>1</sup> / <sub>2</sub>	1	Numbers must be in correct box.  If the candidate gives all the possible values for any quantum number then zero marks should be awarded.

Question			Expected response	Max mark	Additional guidance
2.	(a)	(i)	$K = \frac{[\text{H}_3\text{O}^+(\text{aq})][\text{HOOCCH}_2\text{CH}(\text{OH})\text{COO}^-(\text{aq})]}{[\text{HOOCCH}_2\text{CH}(\text{OH})\text{COOH}(\text{aq})]}$	1	<p>Molecular formula or structure are both acceptable.</p> <p>State symbols are not required but if shown, they must be correct.</p> <p>Square brackets must be used.</p> <p>'k' instead of 'K' would not be acceptable.</p> <p>The inclusion of <math>[\text{H}_2\text{O}]</math> is not acceptable.</p> <p><math>[\text{H}^+]</math> is acceptable instead of <math>[\text{H}_3\text{O}^+]</math></p>
		(ii)	$\text{HOOCCH}_2\text{CH}(\text{OH})\text{COO}^-(\text{aq}) + \text{H}_2\text{O}(\ell) \rightleftharpoons \text{H}_3\text{O}^+(\text{aq}) + ^-\text{OOCCH}_2\text{CH}(\text{OH})\text{COO}^-(\text{aq})$	1	<p>Correct H must be removed.</p> <p><math>(\text{OOCCH}_2\text{CH}(\text{OH})\text{COO})^{2-}</math> is also acceptable for the conjugate base.</p> <p>State symbols are not required but if shown, they must be correct.</p> <p><math>[\text{H}^+]</math> is <b>not</b> acceptable instead of <math>[\text{H}_3\text{O}^+]</math></p>


Question			Expected response	Max mark	Additional guidance
2.	(b)	(i)	<p>2.9 (3)</p> <p>Up to 2 partial marks can be awarded for:</p> <p>1 mark for</p> $\text{pH} = \frac{1}{2} \text{pK}_a - \frac{1}{2} \log_{10} C$ <p>OR</p> $[\text{H}^+] = \sqrt{(\text{K}_a C)}$ <p>1 mark for calculating</p> $\text{pK}_a = 3.5/3.49/3.495$ <p>OR</p> <p>1 mark for correctly calculating a pH value from a calculated concentration of hydrogen ions.</p>	3	<p>3/2.89/2.894 are also acceptable answers.</p> <p>General marking instruction (l) applies.</p>
		(ii)	<p>Hydrogen bonding</p> <p>OR</p> <p>description of hydrogen bonding.</p>	1	



Question			Expected response	Max mark	Additional guidance
3.	(a)		<p>Dissolve/make a solution of the sodium carbonate in distilled/deionised water (in a beaker).</p> <p>Transfer the solution/it and the rinsings.</p> <p>Use of a (250cm<sup>3</sup>) standard/volumetric flask.</p> <p>Make (the solution) up to the mark/line (in a standard/volumetric flask with distilled/deionised water).</p>	2	<p>4 correct to get two marks.</p> <p>2 or 3 to get one mark.</p> <p>One mention of distilled/deionised water and standard/volumetric flask anywhere in the answer is sufficient.</p> <p>Either making a solution or dissolving must be mentioned before making up to the mark.</p> <p>Mention of meniscus alone is not sufficient for making up to the mark.</p> <p>Incorrect size of standard flask is a cancelling error for standard flask.</p>
	(b)	(i)	<p>0.0348 (moles/mol) (2)</p> <p>One partial mark may be awarded for:</p> <p>Multiplying by</p> <p>0.01945 or 19.45 / 1000</p> <p>OR</p> <p>multiplying a calculated number of moles by 10</p> <p>OR</p> <p>correct application of mole ratio.</p>	2	<p>0.035/0.03482/0.034816 are also acceptable answers.</p> <p>If a candidate uses 19.4 or 19.5 then a maximum of 1 mark can be awarded.</p> <p>General marking instruction (l) applies.</p>

Question			Expected response	Max mark	Additional guidance
3.	(b)	(ii)	<p>7 (2)</p> <p>One partial mark may be awarded for:</p> <p>calculating mass of water in the sample = 4.41g</p> <p><b>OR</b></p> <p>calculating mass of water in the GFM for the sample = 126.76 g</p> <p><b>OR</b></p> <p>correctly calculating a mass of water from b(i)</p> <p><b>OR</b></p> <p>correct ratio <math>\text{Na}_2\text{CO}_3 : \text{H}_2\text{O}</math> from a calculated mass / moles of water.</p>	2	<p>Value for n must be a whole number.</p> <p>Allow follow through from b(i).</p>

Question		Expected response	Max mark	Additional guidance
3.	(c)	<p>This is an open ended question .</p> <p><b>1 mark:</b> The student has demonstrated, at an appropriate level, a limited understanding of the chemistry involved. The student has made some statement(s) which is/are relevant to the situation, showing that at least a little of the chemistry within the problem is understood.</p> <p><b>2 marks:</b> The student has demonstrated, at an appropriate level, a reasonable understanding of the chemistry involved. The student makes some statement(s) which is/are relevant to the situation, showing that the problem is understood.</p> <p><b>3 marks:</b> The maximum available mark would be awarded to a student who has demonstrated, at an appropriate level, a good understanding, of the chemistry involved. The student shows a good comprehension of the chemistry of the situation and has provided a logically correct answer to the question posed. This type of response might include a statement of the principles involved, a relationship or an equation, and the application of these to respond to the problem. This does not mean the answer has to be what might be termed an “excellent” answer or a “complete” one.</p>	3	<p>Zero marks should be awarded if:</p> <ul style="list-style-type: none"> <li>the student has demonstrated no understanding of the chemistry involved at an appropriate level.</li> <li>there is no evidence that the student has recognised the area of chemistry involved or has given any statement of a relevant chemistry principle.</li> </ul> <p>This mark would also be given when the student merely restates the chemistry given in the question.</p>

Question			Expected response	Max mark	Additional guidance
4.	(a)		unpaired d electrons  <b>OR</b>  empty/half-filled/incomplete d orbitals/subshell  <b>OR</b>  variable oxidation states  <b>OR</b>  donating and accepting electrons.	1	Mention of the formation of intermediates or providing a surface area for a reaction or lowering the activation energy would not be awarded a mark but are not cancelling errors.
	(b)			1	Any orientation is acceptable.
	(c)		But-1-ene has two hydrogens/the same group on first carbon of the C=C  <b>OR</b>  But-1-ene has three hydrogens attached to the C=C  <b>OR</b>  swapping any of the groups on the C=C results in the same structure.	1	
	(d)	(i) (A)	-126 (kJ mol <sup>-1</sup> )	1	-130/-126.0/-125.99 also acceptable answers.  Units are not required but if included must be correct.

Question			Expected response	Max mark	Additional guidance
4.	(d)	(i) (B)	$-0.0232 \text{ kJ K}^{-1} \text{ mol}^{-1}$ (3) <b>OR</b> $-23.2 \text{ J K}^{-1} \text{ mol}^{-1}$ Up to 2 partial marks can be awarded for: 1 mark for $\Delta G^{\circ} = \Delta H^{\circ} - T\Delta S^{\circ}$ , which may also be rearranged or substituted. <b>OR</b> $\Delta G^{\circ} = -119.1$ 1 mark for $\text{kJ K}^{-1} \text{ mol}^{-1}$ <b>OR</b> $\text{J K}^{-1} \text{ mol}^{-1}$	3	$-0.023/-0.02315/-0.023154$ are also acceptable answers.  $-23/-23.15/-23.154$ are also acceptable answers. General marking instruction (l) applies.  The units are acceptable in any order. The unit must be consistent with the number calculated.
		(ii)	$5430 \text{ (K)}$ (2) Partial Marking One mark can be awarded for: $\Delta G^{\circ} = 0$ <b>OR</b> $T = \Delta H^{\circ} / \Delta S^{\circ}$ <b>OR</b> correct substitution of values.	2	$5400/5431/5431.0$ are also acceptable answers. Follow through from all of d(i) applies. General marking instruction (l) applies. Use of < or > in the final answer for T can be awarded a maximum of one mark.

Question			Expected response	Max mark	Additional guidance
5.	(a)		Conjugated system  OR alternating double and single bonds.	1	Accept a description of a conjugated system.  Chromophore on its own is not enough for the mark to be awarded.
	(b)		Electrons move from HOMO to LUMO. (1)  Absorption of light (from the visible part of the spectrum) means that light of the complementary colour is seen. (1)	2	The direction of electron transitions must be given.  Any mention of emission or dropping energy levels is a cancelling error for the second mark.
	(c)		There is less conjugation  OR a shorter sequence of alternating double and single bonds  OR a smaller chromophore. (1)  Larger gap/greater energy (absorbed). (1)	2	"Fewer double bonds" by itself would not be awarded the first mark.

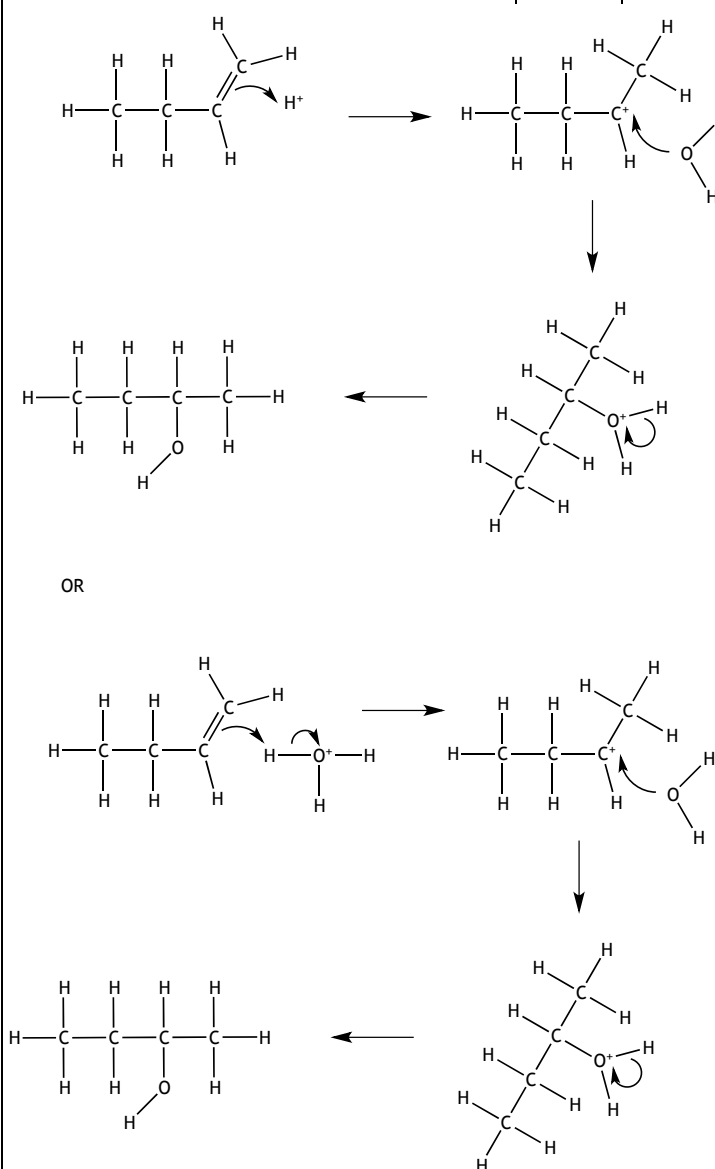
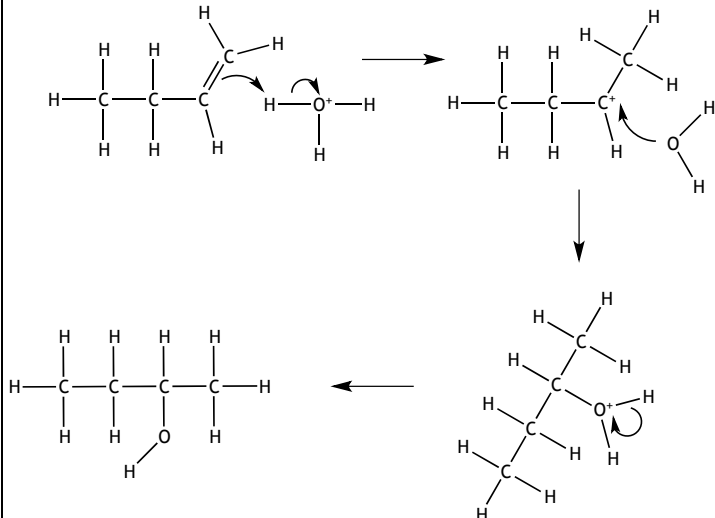
Question			Expected response	Max mark	Additional guidance
6.	(a)		(Ligands) donate (lone/non-bonding) pairs of electrons (to the metal ion)  OR  (ligands) can form dative covalent bonds (with the metal ion).	1	Any mention of donating a bonding pair of electrons is a cancelling error.
	(b)	(i)	$C_3H_8O_3S_3$	1	Any order of elements in the formula is acceptable.
		(ii) A	Bidentate	1	
		(ii) B	4/IV/four	1	Charges are not acceptable.
	(c)	(i)	gravimetric (analysis)	1	
		(ii)	96.1(%) (2)  Partial marking  One mark can be awarded for:  mass of nickel = 0.980(g)  OR  any calculated number divided by 1.02 and multiplied by 100  OR  61.1g of the alloy can make 1 mole of the complex  OR  58.7 divided by a calculated mass of alloy and multiplied by 100.	2	96/96.08/96.081 are also acceptable answers.  General marking instruction (l) applies.

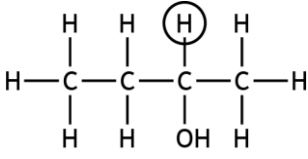
Question			Expected response	Max mark	Additional guidance
7.	(a)	(i)	(Electrophilic) substitution	1	Nucleophilic is a cancelling error.
		(ii)	Secondary	1	
		(iii)	Lithium aluminium hydride  OR  $\text{LiAlH}_4$	1	
		(iv)	(Step) 3	1	
	(b)		0.2 (mg)	1	0.15 (mg) is also an acceptable answer.  Answer must be expressed in milligrams, mg.  Units not required but must be correct if given.
	(c)		The diagram must show labelled start positions (eg spots, crosses or letters) of the extract and pure, on a horizontal line above the level of the solvent.	1	



Question			Expected response	Max mark	Additional guidance
8.	(a)		<p>0.97 (g cm<sup>-3</sup>) (2)</p> <p>Partial Marking:</p> <p>One mark can be awarded for:</p> <p>Mass of ethanol = 10.27</p> <p>AND</p> <p>Mass of water = 87</p> <p>OR</p> <p>correctly calculating the density using one correct mass and one incorrect mass.</p>	2	<p>1/0.973/0.9727 are also acceptable answers.</p> <p>Units not required but if given must be correct.</p>
	(b)		<p>Boiling points are similar</p> <p>OR</p> <p>(some) water evaporates at ethanol's boiling point</p> <p>OR</p> <p>any mention of attraction or forces between water (molecules) and ethanol (molecules).</p>	1	
	(c)		<p>Water (molecules) are smaller than ethanol (molecules)</p> <p>OR</p> <p>ethanol (molecules) are too large to pass through</p> <p>OR</p> <p>ethanol (molecules) are larger than water (molecules)</p> <p>OR</p> <p>water (molecules) pass through but ethanol (molecules) cannot</p> <p>OR</p> <p>water (molecules) are trapped in the sieve.</p>	1	<p>An acceptable answer should demonstrate an understanding of the difference in size between water molecules and ethanol molecules.</p>

Question			Expected response	Max mark	Additional guidance
8.	(d)		<p>This is an open ended question.</p> <p><b>1 mark:</b> The student has demonstrated, at an appropriate level, a limited understanding of the chemistry involved. The student has made some statement(s) which is/are relevant to the situation, showing that at least a little of the chemistry within the problem is understood.</p> <p><b>2 marks:</b> The student has demonstrated, at an appropriate level, a reasonable understanding of the chemistry involved. The student makes some statement(s) which is/are relevant to the situation, showing that the problem is understood.</p> <p><b>3 marks:</b> The maximum available mark would be awarded to a student who has demonstrated, at an appropriate level, a good understanding, of the chemistry involved. The student shows a good comprehension of the chemistry of the situation and has provided a logically correct answer to the question posed. This type of response might include a statement of the principles involved, a relationship or an equation, and the application of these to respond to the problem. This does not mean the answer has to be what might be termed an “excellent” answer or a “complete” one.</p>	3	<p>Zero marks should be awarded if:</p> <ul style="list-style-type: none"> <li>the student has demonstrated no understanding of the chemistry involved at an appropriate level.</li> <li>there is no evidence that the student has recognised the area of chemistry involved or has given any statement of a relevant chemistry principle.</li> </ul> <p>This mark would also be given when the student merely restates the chemistry given in the question.</p>

Question			Expected response	Max mark	Additional guidance
9.	(a)		(Base induced) elimination	1	
	(b)		 <p>OR</p>  <p>One mark for the curly arrow from double bond to hydrogen ion/H<sub>3</sub>O<sup>+</sup> (1)</p> <p>One mark for correct carbocation (1)</p> <p>One mark for two curly arrows showing water attacking and hydrogen being removed from the water (1)</p>	3	<p>Accept correct structures with an ethyl group, –C<sub>2</sub>H<sub>5</sub>.</p> <p>Connectivity for an ethyl group must be correct for the intermediate carbocation.</p>

Question			Expected response	Max mark	Additional guidance
9.	(c)			1	
	(d)	(i)	$\text{rate} = k[\text{C}_4\text{H}_9\text{Br}][\text{OH}^-]$ OR $\text{rate} = k[\text{C}_4\text{H}_9\text{Br}]^1[\text{OH}^-]^1$	1	<p>'K' instead of 'k' would not be acceptable.</p> <p>The charge must be present on the OH.</p> <p>Square brackets must be used.</p>
		(ii)	$1.3 \times 10^{-4} \text{ l mol}^{-1} \text{ s}^{-1}$ (2) Partial marking: One mark can be awarded for: correct value OR correct units.	2	<p><math>1 \times 10^{-4} / 1.32 \times 10^{-4} / 1.320 \times 10^{-4}</math> are also acceptable answers.</p> <p>Allow follow through from d(i) for both the value and the unit.</p> <p>Allow units in any order.</p> <p><math>\text{l}^1 \text{ mol}^{-1} \text{ s}^{-1}</math> is also an acceptable unit.</p>

Question			Expected response	Max mark	Additional guidance
10.	(a)		Delocalised electrons	1	'Electrons in pi bonds' on its own is not an acceptable answer.
	(b)		$1s^2 2s^2 2p^6 3s^2 3p^6 3d^7 (4s^0)$	1	[Ar] $3d^7$ is not an acceptable answer.
	(c)	(i) A	Standard/accurate/solutions or solutions of known concentration (are prepared/used).  A suitable filter/wavelength/colour used.  Mention of a blank or solvent only measurement.  Absorbance/transmittance of each solution is measured/plotted.	2	4 correct to get two marks.  2 or 3 to get one mark.  Reference to intensity, instead of absorbance/transmittance is not acceptable.
		(i) B	The absorbance/transmittance of the unknown is measured  AND  a mention of using the graph.	1	Allow follow through from procedure described in part (i) A.
		(ii)	Propan-1-ol / 1-propanol	1	Mark not awarded for propanol.
	(d)		1 / One (peak)	1	

[END OF MARKING INSTRUCTIONS]