



National
Qualifications
2017

2017 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 or partial marks.
- (f) Unless a numerical question specifically requires evidence of working to be shown, full marks should be awarded for a correct final answer (including units) on its own.
- (g) Larger mark allocations may be fully accessed whether responses are provided in continuous prose, linked statements or a series of developed bullet points.
- (h) 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.
- (i) If a correct answer is followed by a wrong answer, 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 is followed by additional information which does not conflict with that, 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.
- (j) 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.

(k) 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.

(l) 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 to a final answer where a mark has not been awarded due to a significant figure error.

(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, CH₃ and CH₃CH₂ are acceptable as methyl and ethyl groups respectively.

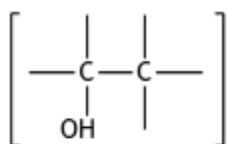
If a name is asked for such as 3-methylhexane, then 3,methyl-hexane would be acceptable, i.e. ignore incorrect use of commas and dashes.

(o) With structures involving an -OH or an -NH₂ group, mark should only be awarded if the "O" or "N" are bonded to a carbon, ie not OH-CH₂ and NH₂-CH₂.

When drawing structural formulae, 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_3H_8 burned to give 82.4 kJ of energy. $\text{C}_3\text{H}_8(\text{g}) + 5\text{O}_2(\text{g}) \rightarrow 3\text{CO}_2(\text{g}) + 4\text{H}_2\text{O}(\text{l})$.' 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, eg "Write the word equation for the complete combustion of ethanol."

Detailed marking instructions for each question

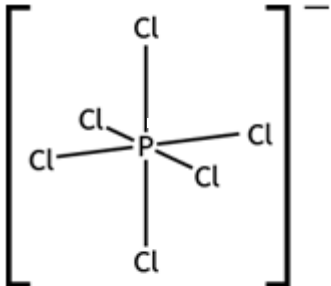
Section 1

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

Section 2

Question			Answer	Max mark	Additional guidance
1.	(a)	(i)	Electrons promoted/excited (1) Falls/moves/jumps to lower level and energy/photon(s)/light is emitted/ released (1)	2	
		(ii)	Different (electron) transitions OR Different energy levels/subshells OR Suitable diagram with explanation	1	
	(b)		186 (kJ mol ⁻¹) 1 mark can be awarded for any one of the following: E= Lhc/1000 λ OR E= Lhc/λ OR f = c/λ and E = Lhf OR $\frac{6.02 \times 10^{23} \times 6.63 \times 10^{-34} \times 3.00 \times 10^8}{(1000 \times) 644 \times 10^{-9}}$	2	Acceptable sig figs range is two to five: 190, 185.9, 185.93 Units not required but if given must be correct as stated in the question.

Question			Answer	Max mark	Additional guidance
2.	(a)	(i)	<p>0.0304</p> <p>Partial marks may be awarded for any of the following:</p> <p>$[\text{PCl}_5] = 0.0580$ (1)</p> <p>$[\text{PCl}_3] [\text{Cl}_2] / [\text{PCl}_5]$ or substitution of values (1)</p> <p>OR</p> <p>$0.0420^2 / 0.0580$ (2)</p>	3	<p>Acceptable sig figs range is two to five: 0.030, 0.03041, 0.030414</p> <p>Final answer must be a numerical value with no unit. A value given with a unit is incorrect.</p> <p>Allow follow through for an incorrect value for $[\text{PCl}_5]$ only if $[\text{PCl}_3]$ and $[\text{Cl}_2]$ are 0.0420</p> <p>Round brackets are not acceptable in the equilibrium expression for a partial mark.</p>
		(ii)	<p>Forward reaction is favoured</p> <p>OR</p> <p>More products formed/less reactants</p> <p>OR</p> <p>Equilibrium shifts to the right (1)</p> <p>K increases (1)</p>	2	<p>Allow follow through from incorrect expression in (a)(i)</p>

Question			Answer	Max mark	Additional guidance
	(b)	(i)		1	<p>Must show square brackets and negative charge on outside of bracket OR negative charge on P with or without brackets.</p> <p>Wedges and dashes not essential but if used must be correct.</p>
		(ii)	<p>Stronger repulsion from π-electrons/double bond</p> <p>OR</p> <p>P=O bond is (more) electron rich</p>	1	<p>Not “from the electrons”</p> <p>Answers such as ‘non-bonding pair-bonding pair repulsion in POCl₃ is greater than bonding pair-bonding pair repulsion’ would be awarded 0 marks.</p>

Question			Answer	Max mark	Additional guidance
3.	(a)	(i)	(A) $\Delta H^\circ = -882 \text{ (kJ mol}^{-1}\text{)}$	1	Units not required but if given must be correct.
			(B) $\Delta S^\circ = -150 \text{ (J K}^{-1}\text{mol}^{-1}\text{)}$	1	Sig figs accept: -147 Units not required but if given must be correct.
		(ii)	5900 (K) (2) A partial mark may be awarded for any of the following: $\Delta G = 0$ OR $T = \Delta H / \Delta S$ OR Correct substitution of values (1)	2	Acceptable sig figs range is one to four: 6000 (K), 5880 (K) Units not required but if given must be correct. Allow follow through from (a)(i)A and/or B Use of > or < in the final answer can only be awarded a maximum of 1 mark.
	(b)		Zinc is passed into a condenser/condensed/distilled OR Zinc is a gas (or answer showing application/understanding of state at 1200K) and collected (at the top) and cooled (1) Lead is a liquid (or answer showing application/understanding of state at 1200K) and collected at the bottom (or answer showing application/understanding of density) (1)	2	Altering the temperature of the furnace is a cancelling error for each metal.

Question			Answer	Max mark	Additional guidance
4.	(a)	(i)	4, IV, +4, 4+, four	1	
		(ii)	<div><div><div>1↓</div><div>1s</div></div><div><div>1↓</div><div>2s</div></div><div><div>1↓</div><div>1↓</div><div>1↓</div><div>2p</div></div><div><div>1↓</div><div>3s</div></div><div><div>1↓</div><div>1↓</div><div>1↓</div><div>3p</div></div><div><div>1</div><div></div><div></div><div></div><div></div><div>3d</div></div></div>	1	<p>All of the orbital boxes opposite must be shown and clearly labelled.</p> <p>Single or double headed arrows are acceptable.</p> <p>Accept diagrams showing an empty 4s orbital box.</p> <p>Allow follow through from (a)(i).</p>
	(b)	(i)	Rate = k [V ³⁺ (aq)] [Fe ³⁺ (aq)]	1	<p>Accept without state symbols but if included they must be correct.</p> <p>Must be a lower case k</p> <p>Round brackets are not acceptable.</p>
		(ii)	<div><div>(A)</div><div>Zero order / 0</div><div>(1)</div><div>Fe³⁺ is not a reactant in slow step /RDS</div><div>OR</div><div>Fe³⁺ only appears in the fast step</div><div>(1)</div></div>	2	<p>If the order is incorrect then 0 marks are awarded.</p> <p>If the order is not given then one mark may be awarded for a correct explanation.</p>

Question			Answer		Max mark	Additional guidance
			(B)	It is in the same state as the ions in the reaction/named reactant(s)/reactant(s).	1	
	(c)		92 mg/0.092 g/ 9.2×10^{-5} kg (2)		2	Acceptable sig figs range is one to four: 90, 92.3, 92.30 0.09, 0.0923, 0.09230 9.0×10^{-5} , 9.23×10^{-5} , 9.230×10^{-5} This mark for units is independent of general marking instruction (l).
			A partial mark may be awarded for any of the following:			
			92/0.092/ 9.2×10^{-5} (1)			
			correct unit consistent with working (1)			

Question			Answer	Max mark	Additional guidance
5.			<p>This is an open ended question</p> <p>1 mark: 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>2 marks: 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>3 marks: 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: The student has demonstrated no understanding of the chemistry involved at an appropriate level. There is no evidence that the student has recognised the area of chemistry involved or has given any statement of a relevant chemistry principle. This mark would also be given when the student merely restates the chemistry given in the question.</p>

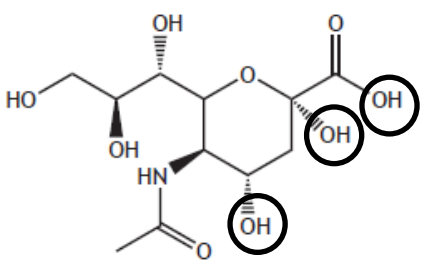
Question			Answer	Max mark	Additional guidance
6.	(a)	(i)	Both electrons/shared pair/bonding electrons come from the same atom/species/molecule/ligand or from a lone pair.	1	An answer that refers to both electrons being donated from one atom <u>to another atom</u> should not be awarded the mark.
		(ii)	Any structure showing a copper ion joined by 4 bonds to one ligand	1	<p>Structure of ligand must be correct for mark to be awarded.</p> <p>Bonds must be between copper and the nitrogen atoms for mark to be awarded. These can be solid lines, dotted lines, dashed or solid wedges.</p> <p>Shape of complex ion should be ignored.</p> <p>Charge is not needed but if included must be correct.</p>
	(b)	(i)	Neutralisation	1	
		(ii)	Partially dissociated (into ions) in solution/water/aq OR Partially ionised in solution/water/aq OR An acid that exists in equilibrium with its ions in solution	1	

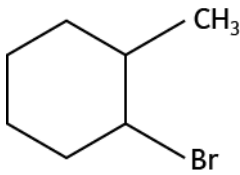
Question			Answer		Max mark	Additional guidance
6.	(b)	(iii)	(A)	desiccator	1	
			(B)	<p>(y=) 2 (2)</p> <p>A partial mark may be awarded for any of the following:</p> <p>Correct moles: 0.023 (0.02279) of zinc ethanoate and 0.046 of water</p> <p>OR</p> <p>$5 / 0.02279$ (0.023) = 219.4 (217.4)</p> <p>$219.4 - 183.4 = 36$ (34)</p> <p>OR</p> <p>A correctly calculated value of y from an incorrectly calculated number of moles</p> <p>(1)</p>	2	y must be whole number
			(C)	<p>Impurities present</p> <p>OR</p> <p>Not fully dry/not heated to constant mass</p> <p>OR</p> <p>Reabsorbed water/not cooled in a desiccator</p> <p>OR</p> <p>Wrong product/side reactions</p> <p>OR</p> <p>Sample decomposed</p> <p>OR</p> <p>Different form of hydrated zinc ethanoate used. (different number of water molecules)</p>	1	Transfer losses/error in balance are not acceptable

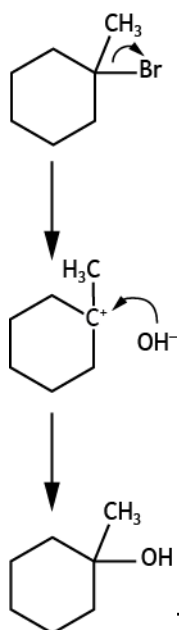
Question			Answer	Max mark	Additional guidance
7.	(a)	(i)	<p>All four points for 2 marks. Two or three points for 1 mark.</p> <ul style="list-style-type: none"> • minimum/small (volume) • hot solvent/hot ethanol/hot ethanol (aq) • filter (to remove impurities) • cool 	2	Filtration must be carried out before the cooling step.
		(ii)	<p>Melting point/mixed melting point</p> <p>OR</p> <p>IR</p> <p>OR</p> <p>NMR</p> <p>OR</p> <p>MS</p> <p>OR</p> <p>Chromatography/TLC</p>	1	Boiling point is not acceptable

Question			Answer	Max mark	Additional guidance
	(b)		<p>0.94 (g) (3)</p> <p>Partial marks may be awarded for any of the following:</p> <p>Using correct mole ratio (2 to 1 phenol to phenolphthalein)/ idea of phthalic anhydride in excess. (1)</p> <p>Calculating theoretical yield (1)</p> <p>Using percentage yield to get final answer (1)</p>	3	<p>Acceptable sig figs range is one to four: 0.9, 0.942, 0.9418</p> <p>Units not needed for final answer but if given must be correct.</p> <p>Follow through applies if phthalic anhydride is used as limiting reagent or correct mole ratio not applied;</p>

Question			Answer	Max mark	Additional guidance
8.	(a)	(i)	$C_6H_{12}O_6$	1	
		(ii)	<p>Any one of the following concepts.</p> <p>Different numbers of peaks/ proton/hydrogen environments</p> <p>OR</p> <p>Different shift patterns</p> <p>OR</p> <p>Different splitting patterns/ number of sub peaks</p> <p>OR</p> <p>Different peak area/heights/ integrals</p>	1	<p>Any mention of a different number of carbon atoms/ hydrogen <u>atoms</u>/OH groups in the compounds is a cancelling error.</p> <p>Any mention of hydrogen environments/shifts that <u>do not</u> exist in either sugar is a cancelling error, eg CH_3, aromatic, benzene</p> <p>Different spectra is not acceptable.</p>
	(b)		<p>The ring/cyclic structure restricts rotation</p> <p>OR</p> <p>Lack of free rotation</p>	1	Mention of double bonds/mirror images etc is a cancelling error.
	(c)	(i)	4	1	

Question			Answer	Max mark	Additional guidance
		(ii)	Accept one, two, three or four chiral centre(s) reflected	1	<p>General marking instruction (o) applies to this mark.</p> <p>Expanded CH₂OH group or reversed HOH₂C group must be correct. Condensed CHO group or reversed OHC group must be correct.</p> <p>Do not accept three groups on any one carbon atom (particularly C₅, the carbon atom adjacent to the CH₂OH) being 'swapped' round.</p>
	(d)	(i)	hydrogen bonding OR dative (covalent) bonding	1	<p>Any other intermolecular force should not be treated as a cancelling error.</p> <p>Ionic interactions is incorrect.</p>
		(ii)	 <p>A minimum of 2 of the 3 circled OH groups.</p>	1	Any other functional groups circled is a cancelling error.

Question			Answer	Max mark	Additional guidance
9.	(a)	(i)		1	Accept any correct structural formula/stereoisomer.
		(ii)	<p>Less stable/unstable carbocation</p> <p>OR</p> <p>More stable carbocation is tertiary/is more substituted/has alkyl group(s)</p>	1	<p>An answer that refers to the number of hydrogen atoms only, with no reference to the stability of a carbocation intermediate, is not acceptable.</p> <p>An answer that refers to a more stable carbocation forming compound X, or a less stable carbocation forming the other/major compound, should be treated as a cancelling error.</p>
	(b)		<p>HCl(aq)/hydrochloric acid</p> <p>OR</p> <p>“H⁺ and H₂O” OR “H⁺/H₂O”</p> <p>OR</p> <p>H⁺ (aq)</p> <p>OR</p> <p>any named (aqueous) acid/dilute acid</p>	1	HCl on its own or any concentrated acid on its own is not acceptable.

Question	Answer	Max mark	Additional guidance
(c)	 <p>This final structure is not required</p>	2	<p>1 mark for intermediate including positive charge</p> <p>1 mark for the correct curly arrows with full arrow heads: First curly arrow, tail is from the bond and head is to the Br. Second curly arrow, tail is from the OH and head is towards the C⁺.</p>
(d)	<p>1-methoxy-1-methylcyclohexane</p> <p>OR</p> <p>1-methyl-1-methoxycyclohexane</p> <p>OR</p> <p>1-methylmethoxycyclohexane</p> <p>OR</p> <p>methyl-1-methoxycyclohexane</p> <p>OR</p> <p>1-methoxymethylcyclohexane</p> <p>OR</p> <p>methoxy-1-methylcyclohexane</p>	1	<p>Methoxymethylcyclohexane is not acceptable.</p> <p>1,1-methylmethoxycyclohexane and 1,1-methoxymethylcyclohexane are not acceptable.</p> <p>Any name ending with “-ene” is not acceptable.</p>

Question			Answer	Max mark	Additional guidance
10.	(a)	(i)	1.4×10^{-3} (mol) (2) A partial mark may be awarded for any of the following: $18.55 \times 10^{-3} \times 0.030 = 5.565 \times 10^{-4}$ moles MnO_4^- in 20 cm^3 OR Correct use of incorrect number of moles of permanganate to calculate moles H_2O_2 in 20 cm^3 (1)	2	Acceptable sig figs range is one to four: $1 \times 10^{-3}/1.39 \times 10^{-3}/1.391 \times 10^{-3}$ Unit is not required but if given must be correct, mol. A unit of "mols" is not acceptable.
		(ii)	1.4 (mol l^{-1}) (2) A partial mark may be awarded for any of the following: $1.4 \times 10^{-3} \times 5 = 0.0070$ moles in 100 cm^3 OR $200 \times$ incorrect number of moles to calculate concentration in 5 cm^3 OR $1.4 \times 10^{-3}/0.02 = 0.07$ (mol l^{-1}) (diluted solution) OR $20 \times$ an incorrect concentration (1)	2	Acceptable sig figs range is one to four: $1/1.39/1.391$ Allow follow through from (a)(i) by $\times 1000$. Unit is not required but if given must be correct.
		(iii)	Titrate with (named) standard solution/solution of known concentration OR Carry out colorimetry with a standard solution/solution of known concentration	1	If standard/known solution is named then it must be appropriate for a redox reaction, such as oxalic acid solution, hydrogen peroxide, etc. Standardising the permanganate solution without mention of titration is not acceptable.

Question		Answer	Max mark	Additional guidance
	(b)	<p>This is an open ended question</p> <p>1 mark: 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>2 marks: 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>3 marks: 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> <p>The student has demonstrated no understanding of the chemistry involved at an appropriate level. There is no evidence that the student has recognised the area of chemistry involved or has given any statement of a relevant chemistry principle. This mark would also be given when the student merely restates the chemistry given in the question.</p>

Question			Answer	Max mark	Additional guidance
11.	(a)	(i)	similar polarities/both non-polar /similar intermolecular forces OR volatile/low boiling point/ evaporates easily OR Inert/unreactive/does not react	1	Both polar is not acceptable. Ether is insoluble in water is not acceptable on its own but is not a cancelling error. “It/trimyristin/ether is soluble” is not a sufficiently detailed response, on its own.
		(ii)	to prevent vapours escaping OR to allow extended heating OR more vigorous heating OR to dissolve/extract maximum OR more efficient	1	“To prevent evaporation of” with no reference to escaping or leaving is not acceptable.
	(b)	(i)	Any single value between 4.5 and 6.0 (inclusive) OR The range 4.5 - 6.0	1	
		(ii)	1 or 3	1	
	(c)		Step 1: (electrophilic) addition (1) Step 2: (nucleophilic) substitution (1)	2	If reactions and reagents given they must be correctly linked. Additional for step 1 is not acceptable Hydration for step 1 is not acceptable Electrophilic substitution for step 2 is not acceptable

[END OF MARKING INSTRUCTIONS]