National
Qualifications
2018

2018 Chemistry

Higher

Finalised Marking Instructions

© Scottish Qualifications Authority 2018

The information in this publication may be reproduced to support SQA qualifications only on a non-commercial basis. If it is reproduced, SQA should be clearly acknowledged as the source. If it is to be used for any other purpose, written permission must be obtained from permissions@sqa.org.uk.

Where the publication includes materials from sources other than SQA (secondary copyright), this material should only be reproduced for the purposes of examination or assessment. If it needs to be reproduced for any other purpose it is the centre's responsibility to obtain the necessary copyright clearance. SQA's NQ Assessment team may be able to direct you to the secondary sources.

These marking instructions have been prepared by examination teams for use by SQA appointed markers when marking external course assessments. This publication must not be reproduced for commercial or trade purposes.

General marking principles for 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, ie marks should be awarded for what is correct and not deducted for 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) There are no half marks 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) In many questions, the unit in which the answer is to be expressed is given. In these questions, the candidate does not need to state a unit in their answer; but if they do, the unit must be correct. The full mark allocation cannot be awarded if an incorrect unit is shown. In these questions, incorrect units would only be penalised once in any paper.

(h) Larger mark allocations may be fully accessed whether responses are provided in continuous prose, linked statements or a series of developed bullet points.

(i) Marks should not be deducted 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.

(j) 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.

(k) 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.

(l) Ignore the omission of one H atom from a full structural formula provided the bond is shown.

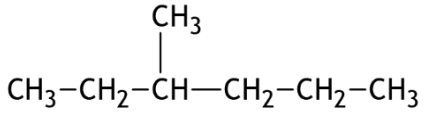
(m) A symbol or correct formula should be accepted in place of a name **unless stated otherwise in the detailed marking instructions.**

(n) 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 be correct. If incorrect charges are shown, no marks should be awarded.

(o) 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 togive 82·4 kJ of energy. $C_3H_8(g) + 5O_2(g) = 3CO_2(g) + 4H_2O(\ell)$. 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.

(p) 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.

Example 1: The structure of a hydrocarbon found in petrol is shown below.



Name the hydrocarbon

- Although the punctuation is not correct '3, methyl-hexane' should gain the full mark.

Example 2: A student measured the pH of four carboxylic acids to find out how their strength is related to the number of chlorine atoms in the molecule. The results are shown.

Structural formula	*pH*
CH_3COOH	1·65
$CH_2ClCOOH$	1·27
$CHCl_2COOH$	0·90
CCl_3COOH	0·51

Describe the relationship between the number of chlorine atoms in the molecule and the strengths of the acids.

- Although not completely correct, an answer such as 'the more Cl_2, the stronger the acid' should gain the full mark.

(q) Unless the question is clearly about a non-chemistry issue, eg costs in an industrial chemical process, a non-chemical answer gains no marks.
For example, in response to the question, 'Why does the (catalytic) converter have a honeycomb structure?', 'to make it work' may be correct but it is not a chemical answer and the mark should not be given.

(r) Marks are awarded only for a valid response to the question asked. For example, in response to questions that ask candidates to:

- **identify, name, give** or **state**, they need only name or present in brief form;
- **describe**, they must provide a statement or structure of characteristics and/or features;
- **explain**, they must relate cause and effect and/or make relationships between things clear;
- **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
- **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;
- **predict**, they must suggest what may happen based on available information;
- **evaluate**, they must make a judgement based on criteria;
- **suggest**, they must apply their knowledge and understanding of [subject] 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 [subject];
- **use your knowledge of [chemistry or aspect 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.”

Marking Instructions for each question

Section 1

Question	Answer	Mark
1.	B	**1**
2.	A	**1**
3.	D	**1**
4.	C	**1**
5.	D	**1**
6.	C	**1**
7.	A	**1**
8.	D	**1**
9.	A	**1**
10.	B	**1**
11.	D	**1**
12.	D	**1**
13.	A	**1**
14.	A	**1**
15.	D	**1**
16.	C	**1**
17.	B	**1**
18.	C	**1**
19.	B	**1**
20	B	**1**

Section 2

Question			Expected response	Max mark	Additional guidance
1.	(a)	(i)	Electronegativity is the measure of attraction an atom/nucleus has for the electrons in a bond/shared electrons.	**1**	
		(ii)	(More shells) so increased shielding/more shielding. **OR** Covalent radius increases/atom size increases/more shells so attraction of the nucleus/protons for the (outer/shared) electrons decreases.	**1**	
	(b)		(Intermolecular) forces/bonds increase (going down the group). **(1)** LDFs are the forces (broken) between the molecules. **(1)** The more electrons the stronger the LDFs. **(1)**	**3**	Use of VdW is acceptable for first mark. Mention of **increasing/stronger** intramolecular/covalent/ionic/ metallic bonds – cancels the first mark. This mark can only be awarded if no other forces are mentioned (as being broken). Use of VdW does not cancel but is not sufficient for the second mark.

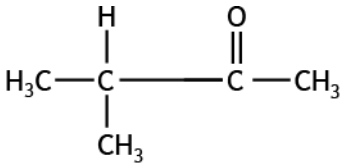
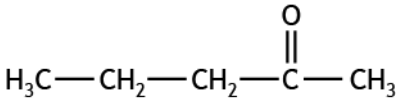
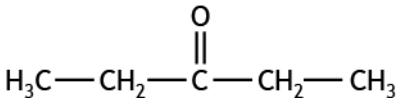
Question			Expected response	Max mark	Additional guidance
2.	(a)		Increasing number of protons (in the nucleus). **OR** Increasing/greater/stronger/higher nuclear charge.	**1**	Mention must be made of **nuclear charge or number of protons.** Increased nuclear pull is not accepted on its own. Increased attraction of the electron for the nucleus is not an acceptable answer.
	(b)	(i)	Sulfur chloride should be circled.	**1**	Accept other indications of correct structure, eg tick, arrow. Do not accept circling of single atoms or bond in SCl_2 molecule on its own.
		(ii)	Silicon tetrachloride and hexane are non-polar. **(1)** Silicon tetrachloride is non-polar due to its shape/dipoles/polarities cancelling out. **(1)**	**2**	Like dissolves like on its own – zero marks - answer must mention polarity.

Question			Expected response	Max mark	Additional guidance
2.	(c)	(i)	Silicon nitride is a (covalent) network. **(1)** (Strong) covalent bonds are broken. **(1)**	**2**	'Covalent lattice' is acceptable, but 'lattice' on its own is not. Mention of silicon is cancelling for the first mark. Covalent network molecule is cancelling.
		(ii)	17·934/17·93/17·9/18 (%) --- Partial mark for correct use of atom economy relationship without correct use of stoichiometry (working must be shown). Partial marks Correct working with no correct answer given. $\frac{140{\cdot}3}{(3\times170{\cdot}1)+(16\times17{\cdot}0)}\times100$ $\frac{140{\cdot}3}{510{\cdot}3+272{\cdot}0}\times100$ $\frac{140{\cdot}3}{782{\cdot}3}\times100$ Incorrect use of stoichiometry. $\frac{140{\cdot}3}{170{\cdot}1+17{\cdot}0}x100=74{\cdot}99$ $\frac{140{\cdot}3}{3\times170{\cdot}1+17{\cdot}0}x100=26{\cdot}6$ $\frac{140{\cdot}3}{170{\cdot}1+16\times17{\cdot}0}x100=31{\cdot}7$ Answer and working must be shown. --- 0·179 **(1)**	**2**	No units required. Only 1 mark can be awarded for the correct answer if wrong unit is given. (Wrong units would only be penalised once in any paper).

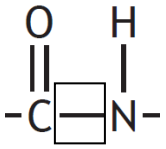
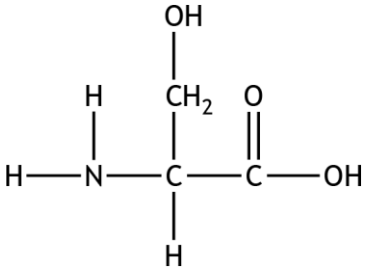
Question			Expected response	Max mark	Additional guidance
2.	(d)	(i)	Diagram shows a workable method for the passing of chlorine gas over heated aluminium. Aluminium must be labelled and there must be an indication of heat. Heated aluminium accepted. **(1)** Diagram allows aluminium chloride to be collected **in a flask** as a solid and chlorine gas to escape. **(1)**	**2**	Labels must be correct.
		(ii)	To provide (initial) activation energy/(sufficient) energy to form activated (activation) complex.	**1**	Accept activation energy is high.

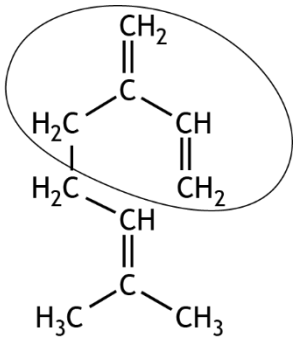
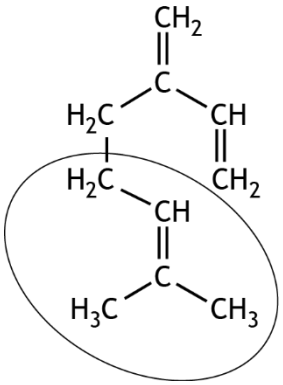
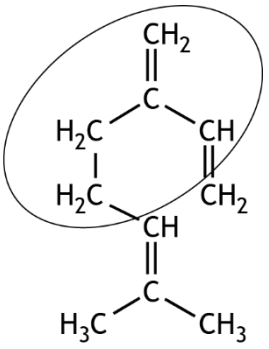
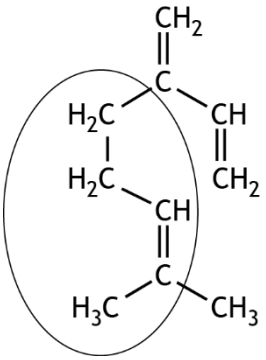
Question			Expected response	Max mark	Additional guidance
3.	(a)		Heating mantle or hot plate **OR** (hot) water bath.	**1**	Any mention of a naked flame would result in the loss of a mark.
	(b)		Condense reactants or products/acts as a condenser/to prevent escape of (volatile/gaseous) reactants or products/to prevent the escape of gas(es).	**1**	Accept correct description of condensation.
	(c)	(i)	Water	**1**	Accept formula H_2O
		(ii)	Correctly calculates number of moles of: Benzoic acid = 0·041 Methanol = 0·078. **OR** Working out that 1·31 g of methanol would be needed to react with 5 g of benzoic acid. **OR** Working out that 9·53 g of benzoic acid would be needed to react with 2·5 g of methanol. **(1)** Statement demonstrating understanding of limiting reactant eg there are less moles of benzoic acid therefore it is the limiting reactant. **OR** There are more moles of methanol therefore it is in excess. **OR** 0·078 moles of methanol would require 0·078 moles of benzoic acid. **(1)**	**2**	

Question			Expected response	Max mark	Additional guidance
3.	(c)	(iii)	(£)12·84 **(2)** Partial Marks Mass benzoic acid = 161·3(g). **OR** Cost to make 3·1g of methyl benzoate = (£) 0·398. **OR** Evidence of a calculated mass of benzoic acid × 7·96 or 8 (p). **(1)**	**2**	Accept 1284 p. Do not accept '1284' on its own; correct units are required. Allow follow through from an initial arithmetic error (for 1 mark). Rounding of final answer to the nearest penny is required.

Question			Expected response	Max mark	Additional guidance
4.	(a)		Correctly drawn structure of pentan- 2-one, pentan-3-one or 3- methylbutanone.   	**1**	Accept full or shortened structural formulae.
	(b)		Fehling's solution/Tollens' reagent/ **acidified** dichromate solution.	**1**	Accept Benedict's solution/Schiff's reagent.
	(c)		Permanent dipole-permanent dipole (interactions/attractions).	**1**	Allow permanent dipole-dipole interaction. Accept pd-pd i's.
	(d)		Will react with oxygen/undergo oxidation. **(1)** Forming a **carboxylic** acid (which has unpleasant taste). **(1)**	**2**	Rancid not acceptable on its own but is not cancelling. Acid not acceptable on its own.
	(e)	(i)	Because it has two molecules joining together with the loss of a small/water molecule.	**1**	Candidates must indicate joining together and loss.
		(ii)	6-methylheptan-2-one	**1**	General marking principle (p) applies.

Question			Expected response	Max mark	Additional guidance
5.			This is an open ended question **1 mark:** The student has demonstrated, at an appropriate level, a limited understanding of the chemistry involved. The candidate 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. **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. **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.	**3**	Zero marks should be awarded if: The student has demonstrated, at an appropriate level, no understanding, of the chemistry involved. 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.

Question			Expected response	Max mark	Additional guidance
6.	(a)	(i)	(enzyme) hydrolysis	**1**	
		(ii)	$C_{20}H_{29}OH$ **OR** $C_{20}H_{30}O$	**1**	
	(b)	(i)	Bond breaking by UV (light) or example of initiation reaction (equation or diagram). eg chlorine splitting to give two free radicals is accepted, provided UV is shown.	**1**	UV on its own is not accepted. Bond breaking on its own is not accepted.
		(ii)	propagation	**1**	
		(iii)	Can react with free radicals forming stable molecules/free radicals (and prevent chain reactions). **OR** Donates electron(s). **OR** Acting as a reducing agent. **OR** Provide electrons to pair with an unpaired electron.	**1**	
	(c)	(i)	Circle any peptide link (CONH).	**1**	 Minimum acceptable structure identified.
		(ii)		**1**	Shortened structural formula accepted.

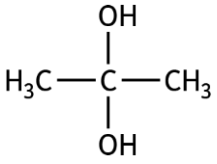
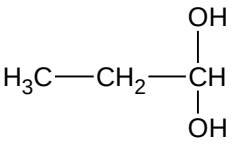
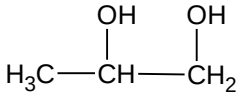
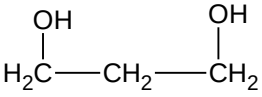
Question			Expected response	Max mark	Additional guidance
7.	(a)	(i)	 	**1**	0 marks awarded for  
		(ii)	Sesquiterpene	**1**	

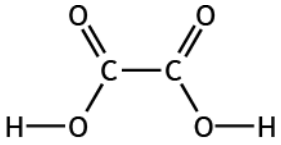
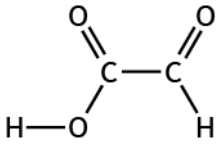
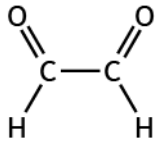
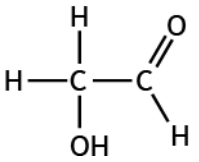
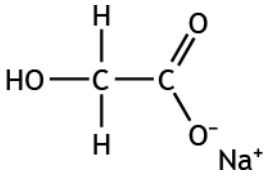
Question			Expected response	Max mark	Additional guidance
7.	(b)	(i)	5·345/5.35/5.3 (kg) **(2)** Partial marking Mass of squalene $= 10{\cdot}69 \times 500\,000$ $= 5\,345\,000$ (mg) **(1)** **OR** For incorrectly calculating mass in mg but correctly converting to kg. **(1)** **OR** For incorrectly calculating mass of squalene but correctly multiplying this by 500 000. **(1)** **OR** Conversion of 10·69 mg to kg ie $10{\cdot}69 \times 10^{-6}$.	**2**	Answer must be in kg to access both marks, 5345 g would be awarded 1 mark only.
		(ii)	6/six (moles)	**1**	
	(c)	(i)	Addition **OR** hydration.	**1**	Oxidation is not accepted.
		(ii)	(terpineol) is a tertiary alcohol (and cannot be oxidised).	**1**	'cannot be oxidised' on its own is awarded zero marks.

Question			Expected response	Max mark	Additional guidance
8.	(a)		286 (kJ mol^{-1}) Partial mark 1 mark Evidence of the use of **all** the correct bond enthalpies (or correct multiples thereof) (412, 348, 838, 436 (ignore signs)). **OR** If only three values are retrieved, the candidate recognises that bond breaking is endothermic and bond formation is exothermic and correctly manipulates the bond enthalpy values they have used to give their answer.	**2**	-286 (kJ mol^{-1}) 1 mark No units required. Only 1 mark can be awarded for the correct answer if wrong unit is given. (Wrong units would only be penalised once in any paper). kJ is acceptable in place of kJ mol^{-1} (KJ or Kj or KJ mol^{-1} or Kj mol^{-1} accepted). If fewer than three bond enthalpy values are retrieved then zero marks can be awarded.
	(b)		(+) 185 (kJ mol^{-1}) [(-1182) + (-572) + (+1939)] = (+) 185 (kJ mol^{-1}) Partial marks Treat as two concepts. Either would be acceptable for 1 mark. Evidence of understanding of reversal of third enthalpy value ie +1939 or 1939 must be seen. The other two enthalpy values (regardless of value) **must** be negative, or this partial mark cannot be awarded. **OR** Evidence of understanding of multiplying the first enthalpy value by 3 and the second enthalpy value by 2. Ignore the enthalpy signs associated with these numbers ie any combination of 3 (±394) **and** 2 (±286) **OR** ±1182 **and** ±572 Multiplication of the third enthalpy value by any factor is taken as cancelling of this partial mark.	**2**	If answer given is −185, maximum of 1 mark can be awarded. No units required. Only 1 mark can be awarded for the correct answer if wrong unit is given. (wrong units would only be penalised once in any paper) kJ is acceptable in place of kJ mol^{-1} (KJ or Kj or KJ mol^{-1} or Kj mol^{-1} accepted).

Question			Expected response	Max mark	Additional guidance
8.	(c)	(i)	48475 (kJ)	**1**	−48475 (kJ) is accepted. No units required. Zero marks can be awarded for the correct answer if wrong unit is given. kJ mol^{-1} is not an acceptable unit in this question. (Wrong units would only be penalised once in any paper).
		(ii)	13·76/13·8/14 (g) Partial mark - 1 mark Mass of oxygen required = 3·2 (g) **OR** 550·4 (g)	**2**	Accept correctly calculated answer in mg or kg, providing units are shown with answer. This is obtained from an incorrect mass of oxygen ($4 \times 32 = 128$) being calculated.
		(iii)	Methanol and ethanol contain oxygen in their structure, (so less additional oxygen is required).	**1**	Contains hydroxyl (groups) not sufficient on its own. Contains -OH is not considered sufficient on its own.

Question			Expected response	Max mark	Additional guidance
9.	(a)	(i)	**1 mark each** for any two of the following points. • recycle (waste) gases • use catalyst • low/reduce energy requirements • reactors are run at low temperatures/the temperatures in the reactors is lowered • inexpensive feedstocks • selling/using by-products	**2**	Recycle by-products is not accepted.
		(ii)	(fractional) distillation	**1**	Evaporation followed by condensation or a correct description of distillation are accepted.
	(b)		Propan-1-ol has fewer hydroxyl groups than ethane-1,2-diol / ethane-1,2-diol has more hydroxyl groups/propan-1-ol has 1 hydroxyl group and ethane-1,2-diol has 2. **(1)** Weaker/fewer hydrogen bonds between propan-1-ol molecules. **OR** Stronger/more hydrogen bonds between ethane-1,2-diol molecules. **(1)**	**2**	"It", if given in answer is taken to refer to ethane-1,2-diol.

Question			Expected response	Max mark	Additional guidance
9.	(c)		Structure of propane-1,2-diol or propane-1,3-diol or propane-1,1-diol or propane-2,2-diol.    	**1**	With structures involving an – OH group, no mark can be awarded if the 'O' is not bonded to a carbon, ie OH–CH_2.
	(d)	(i)	Pipette (used to measure 20cm^3 of ethanol.) **(1)** Statement of use of **volumetric/ standard** flask to make up to / fill to the mark/ to 100cm^3. **(1)**	**2**	Not acceptable to use burette.
		(ii)	157·5(cm^3)	**1**	No units required. No mark can be awarded for the correct answer if wrong unit is given. (Wrong units would only be penalised once in any paper).

Question			Expected response	Max mark	Additional guidance
9.	(d)	(iii) (A)	 **OR**  **OR**  **OR** 	**1**	Accept correct shortened structural formula. With structures involving an – OH group, no mark can be awarded if the 'O' is not bonded to a carbon, ie OH–CH_2. General marking instruction (l) is suspended here.
		(iii) (B)	Correct molecular formula ($NaC_2H_3O_3$) **OR** shortened structural formula ($HOCH_2COONa$) **OR** any full structural formula which shows the correct salt. 	**1**	Structures showing covalent bonds between Na and glycolate are not accepted. Charges are not required but if shown must both be shown and correct.

Question			Expected response	Max mark	Additional guidance
10.			This is an open ended question **1 mark:** The student has demonstrated, at an appropriate level, a limited understanding of the chemistry involved. The candidate 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. **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. **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.	**3**	Zero marks should be awarded if: The student has demonstrated, at an appropriate level, no understanding, of the chemistry involved. 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.

Question			Expected response	Max mark	Additional guidance
11.	(a)		Correct description of weighing by difference. **OR** Correct description of use of the Tare function.	**1**	'weighing by difference' on its own is accepted.
	(b)		$2I^-(aq) \rightarrow I_2(aq) + 2e^-$ **OR** $2I^-(aq) \rightarrow I_2(s) + 2e^-$	**1**	State symbols not required. Negative sign on electron not required.
	(c)	(i)	$9{\cdot}5(cm^3)$	**1**	No units required but no mark is awarded if wrong unit is given. (Wrong units would only be penalised once in any paper).
		(ii)	$4{\cdot}75 \times 10^{-6}$ moles Partial mark for correct use of mole ratio. **OR** Determination of number of moles without using the mole ratio.	**2**	Allow follow through from c (i).

Question			Expected response	Max mark	Additional guidance
12.	(a)	(i)	More/adding chlorine(s). **(1)** More/adding carbon(s). **OR** Adding an alkyl/hydrocarbon chain/group. **OR** Longer/bigger carbon/hydrocarbon/ alkyl (chain/group). **(1)**	**2**	(More) branches is not accepted.
		(ii)	2-chloro-4,5-dimethylphenol	**1**	Apply general marking instruction (p).
	(b)	(i)	126·9/127(kg) Partial mark either for: Calculation of the theoretical yield 141 (no unit required) **(1)** **OR** for correctly calculating 90% of an incorrectly calculated theoretical yield. **(1)**	**2**	No units required but a maximum of 1 mark is awarded if wrong unit is given. (Wrong units would only be penalised once in any paper). Accept correctly calculated answer in g, providing units are shown with answer, eg 126900 g.
		(ii)	Propanone **OR** Acetone **OR** propan-2-one.	**1**	Structure is not acceptable on its own.

[END OF MARKING INSTRUCTIONS]