National
Qualifications
2015

2015 Chemistry

New Higher

Finalised Marking Instructions

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

(h) 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.

(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. **I**f a candidate lists a number of possible answers it should not be for the marker to choose the correct answer from the list

(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) Ignore the omission of one H atom from a full structural formula provided the bond is shown or of one bond if the hydrogen is shown.
When structures involving an –OH group or an $-NH_2$ are asked for, a mark should only be deducted when a bond is drawn to the wrong atom, if understanding of the functional group structure is required.

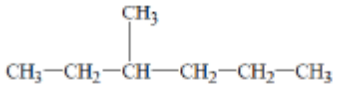
(l) A symbol or correct formula should be accepted in place of a name unless stated otherwise in the detailed marking instructions.

(m) 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.

(n) 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. $C_3H_8(g) + 5O_2(g) = 3CO_2(g) + 4H_2O(\ell)$. 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.

(o) 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.

(p) 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.

(q) 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;

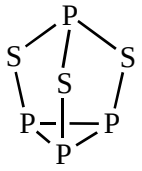
- **compare**, they must demonstrate knowledge and understanding of the similarities and/or differences between things;
- **complete**, they must finish a chemical equation or fill in a table with information
- **determine** or **calculate**, they must determine a number from given facts, figures or 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."

Detailed Marking Instructions for each question

Section 1

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

Section 2

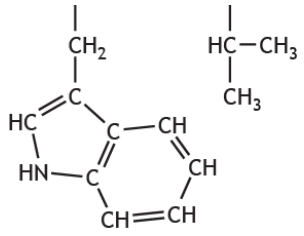
Question			Answer	Max Mark	Additional Guidance
1.	**(a)**		Sulfur – London dispersion forces / van der Waals / intermolecular forces **(1)** Silicon dioxide – (polar)covalent (network) bonds **(1)**	**2**	Accept LDF for London dispersion forces If candidate answers pure covalent, ignore pure.
	(b)	**(i)**	Any structure for P_4S_3 that obeys valency rules 	**1**	Only trivalent phosphorus structures accepted
		(ii)	Increased nuclear attraction for electrons / increased nuclear charge / sulfur has more protons in nucleus	**1**	0 marks awarded for increased attraction of electrons for nucleus
		(iii)	**1 mark** Correctly identify that the forces are stronger between sulfur (molecules) than between the phosphorus molecules **1 mark** Correctly identifying that there are London dispersion forces between the molecules of both these elements **1 mark** These forces are stronger due to sulfur structure being S_8 whereas phosphorus is P_4	**3**	This mark should only be awarded if no other forces are mentioned Must mention S_8 and P_4 (A-mark)
2.	**(a)**		From graph, rate = 0·022 t = 1/rate = 45 s accept answers in range 45 − 46 s	**1**	Units not required
	(b)	**(i)**	Second line displaced to left of original. Peak of curve should be to the left of the original peak	**1**	
		(ii)	A vertical line drawn at a lower kinetic energy that the original E_a shown on graph	**1**	

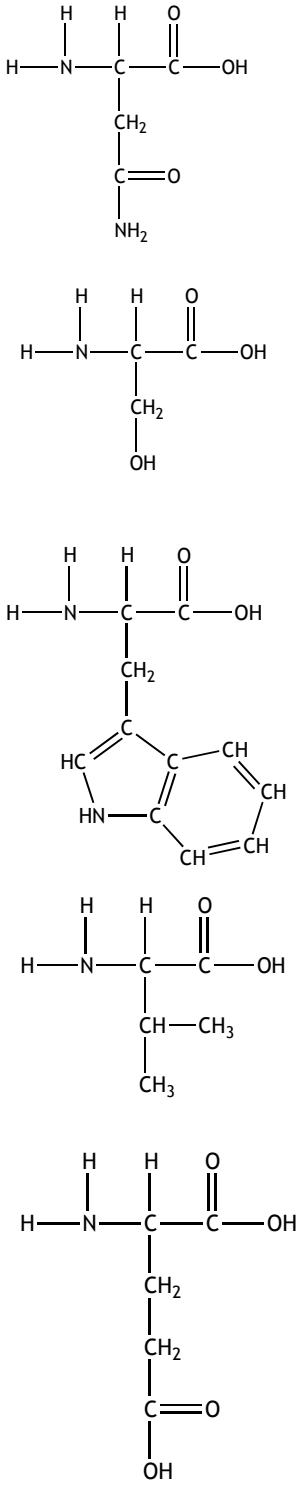
Question			Answer	Max Mark	Additional Guidance
3.	**(a)**	**(i)**	Workable apparatus for passing steam **through** strawberry gum leaves **(1)** Workable apparatus for condensing the steam and essential oil **(1)**	**2**	Treat both marks separately "Through" not "over" A closed system would not allow candidates to gain mark for condensation.
		(ii)	(Fractional) distillation or chromatography	**1**	
	(b)	**(i)**	**1 mark** awarded for correct arithmetical calculation of moles of acid = 0·044 **and** moles alcohol = 0·063 (no penalty for candidates who round to 0·04 and 0·06 etc) **or** working out that 9·25 g cinnamic acid would be needed to react with 2 g methanol or 6·5 g cinnamic acid would react with 1·41 g methanol **1 mark** awarded for statement demonstrating understanding of limiting reactant. eg there are less moles of cinnamic acid therefore it is the limiting reactant **or** 0·0625 moles methanol would require 0·625 moles cinnamic acid **or** methanol is in excess therefore cinnamic acid is the limiting reactant.	**2**	

Question			Answer	Max Mark	Additional Guidance
		(ii) (A)	52% **(2)** Partial Marking 1 mark is given for working out the theoretical yield ie 7·1 g or for working out **both** the moles of reactant used and product formed ie **both** 0·044 moles and 0·023 moles 1 mark is given for calculating the % yield, either using the actual and theoretical masses, or using the actual number of moles of products and actual number of moles of reactant	**2**	**0 marks awarded for** – 3·7/6·5 × 100 or 56·9%
		(ii) (B)	£24·59 **(2)** Partial marking for **1 mark** Award 1 mark for Evidence for costing to produce of 3·7 g (£0·91) **or** evidence of a calculated mass of cinnamic acid x 14p **or** evidence that 176 g of cinnamic acid required £12·80 would be using 100% yield	**2**	Assume units are £ unless otherwise stated Apply follow through from (b) (ii) (A)

Question			Answer	Max Mark	Additional Guidance
4.	**(a)**		Any one of the common compounds correctly identified ie citronellol / geraniol / anisyl alcohol	**1**	
	(b)		The concentration / volume of compounds (that are common to both/present in the counterfeit) is different are present in lower concentration in the counterfeit	**1**	Answer must relate to the perfume and not to the chromatogram.
	(c)	**(i)**	Inert / will not react with the molecules (being carried through the column)	**1**	
		(ii)	Size (mass) of molecules / temperature of column.	**1**	
	(d)	**(i)**	Terpenes	**1**	
		(ii) (A)	3,7-dimethylocta-1,6-dien-3-ol	**1**	
		(ii) (B)	Hydroxyl attached to C which is attached to 3 other C atoms **or** hydroxyl attached to a C that has no H atoms attached	**1**	
	(e)		1·7 g (units not required) **(2)** partial marking **for 1 mark** for evidence within candidate answer of calculating that 1 mg coumarin is obtained from 0·227 g cinnamon or tolerable daily intake =7·5mg for 75kg individual or evidence of multiplying DTI by 227 (multiplying by 1000 and dividing by 4·4)	**2**	

Question			Answer	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 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. **2 marks:** The student has demonstrated a reasonable understanding, at an appropriate level, 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 a good understanding, at an appropriate level, 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 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.

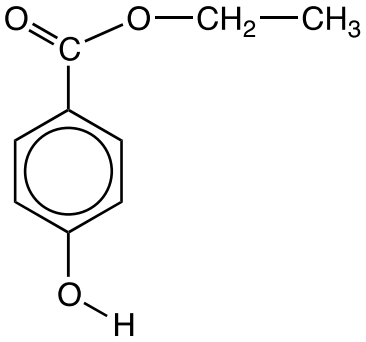
Question			Answer	Max Mark	Additional Guidance
6.	**(a)**		Heat breaks hydrogen bonds	**1**	
	(b)	**(i)**	Either of structures shown circled 	**1**	
		(ii)	50·5 ± 1 °C	**1**	
	(c)	**(i)**	Hydrolysis	**1**	
		(ii) (A)	5	**1**	

Question			Answer	Max Mark	Additional Guidance
		(ii) (B)	Correctly drawn amino acid structure 	**1**	Ignore bond positioning in side chains

Question			Answer		Max Mark	Additional Guidance
7.	**(a)**		118/32 or 3·69 mol CH_3OH **(1)** 3·69 × 24 = 88·5 litres **(1)**		**2**	Units not required but if given need to be appropriate to the calculation. eg 88 500 cm^3 Follow through applies. eg 1 mark can be awarded if use 64 for GFM giving an answer of 44·25 litres **or** for an arithmetically correct answer derived by multiplying a wrongly calculated number of moles (for which working shown) by 24
	(b)	**(i)**	(A)	Thermometer touching bottom or directly above flame or temperature rise recorded would be greater than expected.	**1**	
			(B)	Distance between flame and beaker **or** Height of wick in burner Same type of beaker (this needs to be qualified) Same draught proofing	**1**	
			(C)	2 concept marks + 1 arithmetic mark Concept marks Demonstration of the correct use of the relationship $E_h = cm\Delta T$ **(1)** eg 4·18 × 0·1 × 23 **or** 9·61 **and** Knowledge that enthalpy of combustion relates to 1 mol **(1)** evidenced by scaling up of energy released Correct arithmetic = −288 kJ mol^{-1} **(1)** Allow follow through of wrong GFM from part (a)	**3**	Maximum of 2 marks can be awarded if negative enthalpy sign is not shown in final answer. If candidate converts 1·07g to 0·033 mol, then candidate answer should be −291 kJ mol^{-1} Units not required

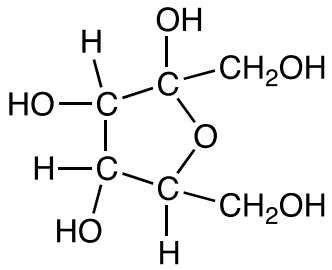
Question			Answer	Max Mark	Additional Guidance
		(ii)	0·799 (0·8)	**1**	Units not required
	(c)	**(i)**	If reactions are exothermic heat will need to be removed / If reactions are endothermic heat will need to be supplied **or** Chemists can create conditions to maximise yield	1	This is not a mark about safety
		(ii)	Answer = +191 kJ mol^{-1} **(2)** Partial mark 1 mark Evidence of the use of **al**l the correct bond enthalpies**.** **(1)** (412, 360, 463, 436, 743) **or** Correct use of incorrect bond enthalpy values	**2**	Positive sign does not need to be given in answer
8.	**(a)**		Calcium carbonate / carbon dioxide / ammonia / calcium oxide **all** correctly identified in flow diagram **(1)** Ammonium chloride / sodium hydrogen carbonate / sodium carbonate / water – all correctly identified in flow diagram **(1)**	**2**	
	(b)		(Adding brine) increases sodium ion concentration hence equilibrium shifts to right **(1)** Rate of forward reaction is increased (by addition of brine) **(1)**	**2**	

Question			Answer	Max Mark	Additional Guidance
9.			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) at 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			Answer	Max Mark	Additional Guidance
10.	**(a)**	**(i)**	24 hours allows time for all of the zinc to react **(1)** No stopper allows hydrogen gas to escape from the flask. **(1)**	**2**	
		(ii)	Zinc ions / impurities / metal ions / salts may be present in tap water	**1**	
	(b)	**(i)**	pipette	**1**	Do not accept measuring cylinder or syringe or burette
		(ii)	10 (Units not required, if given mg per litre, mg l^{-1})	**1**	Accept 0·01 g l^{-1}
	(c)		Answer in range 4·6 – 4·8 (mg per litre, mg l^{-1})	**1**	A-mark Use candidate best fit line, if provided, to check answer
11.	**(a)**		Carboxyl / carboxylic (acid) group	**1**	
	(b)		Esterification / condensation	**1**	
	(c)			**1**	
	(d)		As molecular size (no. of carbon atoms) increases, the absorption decreases.	**1**	

Question			Answer	Max Mark	Additional Guidance
12.	**(a)**	**(i)**	3 points **1 mark** for rinsing the burette – rinse the burette with the **thiosulfate / required solution** / with the solution to be put in it. **2 marks (1 mark each)** for any 2 of the following points fill burette above the scale with thiosulfate solution filter funnel used should be removed tap opened / some solution drained to ensure no air bubbles (thiosulfate) solution run into scale reading should be made from bottom of meniscus	**3**	
		(ii)	$2I^-(aq) \longrightarrow I_2(aq) + 2e^-$	**1**	Ignore state symbols

Question			Answer	Max Mark	Additional Guidance
		(iii)	0·000062 (mol l^{-1}) Partial marks can be awarded using a scheme of two "concept" marks, and one "arithmetic" mark **1 mark** for knowledge of the relationship between moles, concentration and volume. This could be shown by one of the following steps: Calculation of moles thiosulfate solution eg 0·001 × 0·0124 = 0·0000124 **or** calculation of concentration of iodine solution eg 0·0000062/0·1 **or** Insertion of correct pairings of values for concentration and volume in a valid titration formula **1 mark** for knowledge of relationship between moles of thiosulfate and hypochlorite. This could be shown by one of the following steps: Calculation of moles hypochlorite from moles thiosulfate – eg 0·0000124/2 = 0·0000062 **or** Insertion of correct stoichiometric values in a valid titration formula **1 mark** is awarded for correct arithmetic through the calculation. This mark can only be awarded if both concept marks have been awarded.	**3**	units not required

Question			Answer	Max Mark	Additional Guidance
	(b)		**1 mark** correct arithmetic either 44·4 (litres) or 44400 (cm^3) **1 mark** correct units	**2**	
	(c)	**(i)**	**1 mark** Ammonia is polar and trichloramine is non-polar. **1 mark** Explanation of this in terms of polarities of bonds or electronegativity differences of atoms in bonds	**2**	
		(ii)	Substances that have unpaired electrons	**1**	
		(iii)	Propagation	**1**	
13.	**(a)**		Aldehyde group correctly identified	**1**	
	(b)		Ring form correctly drawn 	**1**	

[END OF MARKING INSTRUCTIONS]