H

National
Qualifications
2017

2017 Chemistry

Higher
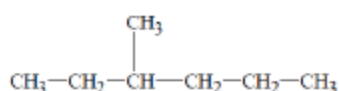
Finalised Marking Instructions

SQA

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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 <u>always</u> 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) 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.

(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.

(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."

Marking instructions for each question

Section 1

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

Section 2

Question			Answer	Max mark	Additional guidance
1.	(a)		Silicon	**1**	Accept symbol
	(b)	(i)	Increasing/greater/stronger/higher nuclear charge (holds electron more tightly) **OR** Increasing number of protons	**1**	Increased nuclear pull is not accepted on its own. Mention must be made of nuclear charge **or** number of protons.
		(ii)	$Mg^+(g) \longrightarrow Mg^{2+}(g) + e^-$	**1**	State symbols required.
		(iii)	Fourth ionisation energy involves removal of an electron from an electron shell which is inner/full (whole)/(more) stable/closer to the nucleus **OR** fourth electron is removed from an electron shell which is inner/full (whole)/(more) stable/closer to the nucleus. **OR** removing third electron is taking from an outer/a part full shell **OR** taking an electron from a full shell requires more energy (than removing from a part full shell) **OR** taking an electron from a part full shell requires less energy (than removing from a full shell) **OR** fourth electron is less shielded than the third electron **OR** third electron is more shielded than the fourth electron	**1**	

	Question		Answer	Max mark	Additional guidance
	(c)		1 mark - Correctly identify that there are stronger/more (Van der Waals) forces between chlorine (molecules) than between the argon (atoms)	3	
			1 mark - Correctly identifying that the van der Waals forces present in both these elements are London dispersion forces		This mark can only be awarded if no other forces are mentioned as being broken.
			1 mark Chlorine molecules (Cl_2) have more electrons than argon atoms (Ar).		

Question			Answer	Max mark	Additional guidance
2.	(a)	(i)	I-I bond is weaker/has a lower bond enthalpy value (so will break more easily) **OR** I_2 (151 kJ mol^{-1}) is less than H_2 (436 kJ mol^{-1}), (so will break more easily).	**1**	Iodine on its own is not acceptable.
		(ii)	Peak of curve should be further to the right and no higher than the original line.	**1**	
		(iii) (A)	Equilibrium will shift to the reactant side/left (hand side).	**1**	
		(iii) (B)	There are the same/equal volume/ number of moles/molecules (of gases) on each side (of the equation). **OR** Pressures of reactants and products are equal.	**1**	Ratios on their own, without an explanation, are not acceptable eg 1:1 or 2:2
		(iv) (A)	Activated complex	**1**	Accept activation complex or transition state.
		(iv) (B)	-9·6 (kJ) If candidate has calculated from graph values **OR** -9 (kJ) If candidate has calculated using bond enthalpies Answer must include the negative sign	**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) kJ mol^{-1} is acceptable in place of kJ
		(iv) (C)	Decrease/lower it	**1**	

Question			Answer	Max mark	Additional guidance
(b)	(i)		To keep the concentration (of the reactants) constant. **OR** Adding water will change/affect/dilute/decrease the concentration (of the reactants) **OR** To keep the total volume constant.	**1**	
	(ii)		122·1 (accept 122) (s)	**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)
	(iii)		The number of (successful) collisions will decrease. **OR** Less chance of (successful) collisions **OR** The frequency of (successful) collisions will decrease.	**1**	Any mention of time of collisions is unacceptable.

Question	Answer	Max mark	Additional guidance
3.	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
4.	(a)	(i)	Pentan-1-ol	**1**	Pentanol is not acceptable.
		(ii)		**1**	Candidates should be awarded zero marks if they draw a covalent bond between O and Na. Charges not required but if shown they must **both** be correct. Accept shortened structural formulae.
	(b)	(i)	ester	**1**	
		(ii)	soap	**1**	Accept emulsifier or detergent.
		(iii)	395 or -395 (kJ) Partial marking one mark can be awarded for **the correct application of number of moles of stearic acid** eg 10/284 x 623 or 0·0352 x 623 (=21.94) (=21.93) or 10/284 x 18 or 0·0352 x 18 (=0.634) (=0.634) **OR** **the correct application of the stoichiometry** eg the energy change for 1 mole of stearic acid as 623 x 18 = 11214 (kJ) or 284 g ←→ 623 x 18	**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		Answer	Max mark	Additional guidance
5.	(a)	(i)	Diagram shows a workable method of bubbling through concentrated sulfuric acid. 1 mark Diagram for appropriate gas collection method i.e. using a gas syringe or upward displacement of air. 1 mark	**2**	
		(ii)	Calculating that 0·05 moles HCl would require 0·025 moles sodium sulfite and there are only 0.00317 moles of sodium sulfite **OR** Calculating that 0·00317 moles of sodium sulfite would require 0·00634 moles of HCl and there are 0.05 moles of HCl **OR** Calculating that 3·15 g sodium sulfite would be needed to react with 50 cm^3 hydrochloric acid and there are only 0.4 g of sodium sulfite **OR** Calculating that 6·3 cm^3 of (1 M) HCl would be needed to react with 0·4 g of sodium sulfite and there are 50 cm^3 (1M) HCl	**2**	General marking principle (j) applies. Partial marking 1 mark awarded for correct arithmetical calculation of moles of Na_2SO_3 (= 0·00317 mol) **AND** HCl = 0·05 mol) **OR** 1 mark awarded for correct arithmetical calculation of moles of acid (0.05) and correct application of stoichiometry to either reactant. **OR** 1 mark awarded for correct arithmetical calculation of moles of sodium sulfite (0.00317) and correct application of stoichiometry to either reactant.

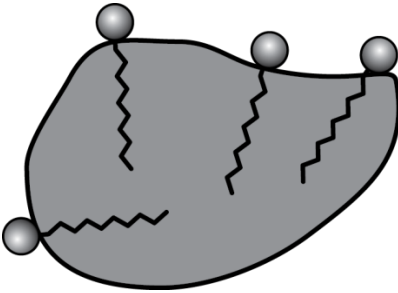| Question			Answer	Max mark	Additional guidance
	(b)		-1075 (kJ mol^{-1}) Partial marks Treat as two concepts either would be acceptable for 1 mark Evidence of understanding of reversal for third equation only in order to achieve the target equation. Reversal of additional equations would be taken as cancelling **OR** evidence of understanding of multiplying for second equation by 2 in order to achieve the target equation. Multiplication of additional equations would be taken as cancelling.	**2**	If answer given is 1075 or +1075, 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}
	(c)	(i)	163 -167 inclusive (g l^{-1})	**1**	No units required. No mark can be awarded for correct answer if wrong unit is given. (wrong units would only be penalised once in any paper)
		(ii)	1 mark for carbon dioxide is non-polar due to its shape/dipoles cancelling out **and** sulfur dioxide is polar due to its shape/dipoles not cancelling out 1 mark for an explanation which links polarity of CO_2 and SO_2 molecules to the polarity of water	**2**	

Question			Answer	Max mark	Additional guidance
6.	(a)	(i)	H—C—C—C—C—H (structure with OH on second carbon)	1	Accept a correct shortened structural formula
		(ii) (A)	Reactants or products are flammable/could catch fire.	1	
		(ii) (B)	orange to green/ blue-green/blue	1	
		(ii) (C)	Tertiary	1	
		(iii) (A)	Butanoic acid **OR** (2-)methylpropanoic acid	1	
		(iii) (B)	$C_4H_9OH + H_2O \rightarrow C_4H_8O_2 + 4H^+ + 4e^-$	1	Negative sign on electron not required. Positive sign on H^+ required.
	(b)	(i)	2-methylpentanal	1	2-methylpentan-1-al is not acceptable.
		(ii)	Any temperature between 166 and 181 ($^{\circ}$C)	1	No units required. No mark can be awarded if wrong unit is given. (wrong units would only be penalised once in any paper)
		(iii)	(More) branching lowers the boiling point (of isomeric aldehydes).	1	
		(iv)	Silver mirror/silver precipitate	1	Accept silver on its own
	(c)		(Permanent) dipole to (permanent) dipole	1	Accept London Dispersion Forces

	Question		Answer	Max mark	Additional guidance
7.	(a)		Rinse beaker and transfer the rinsings/washings to the flask	**1**	
	(b)	(i)	The reaction is self-indicating. **OR** Potassium permanganate can act as its own indicator. **OR** Reaction changes colour.	**1**	
		(ii)	To provide H^+ ions for the reaction.	**1**	
		(iii) (A)	**1 mark** for any of the following • first titre is a rough (or approximate) result/practice • first titre is not accurate/not reliable/rogue • first titre is too far away from the others • you take average of concordant/close results	**1**	

Question			Answer	Max mark	Additional guidance
		(iii) (B)	0·0582 (mol l⁻¹) **(3)** Partial marks can be awarded using a scheme of two "concept" marks. **1 mark** for knowledge of the relationship between moles, concentration and volume. This could be shown by any <u>one</u> of the following steps: • Calculation of moles MnO_4^- solution eg 0·02 × 0·01455 = 0·000291 • calculation of concentration of Fe^{2+} solution eg 0·001455/0·025 • Insertion of correct pairings of values for concentration and volume in a valid titration formula eg $$\frac{0\cdot02 \times 14\cdot55}{n_1} = \frac{C_{Fe^{2+}} \times 25\cdot0}{n_2}$$ **1 mark** for knowledge of relationship between moles of MnO_4^- and Fe^{2+}. This could be shown by one of the following steps: • Calculation of moles Fe^{2+} from moles MnO_4^- – eg 0·000291x5 = 0·001455 • Insertion of correct stoichiometric values in a valid titration formula eg $$\frac{0\cdot02 \times 14\cdot55}{1} = \frac{C_{Fe^{2+}} \times 25\cdot0}{5}$$	3	No units required but only two marks can be awarded for correct answer if wrong unit is given. (wrong units would only be penalised once in the paper) In terms of the mark for the stoichiometric relationship, the 5 should be associated with the unknown concentration of the Fe^{2+} and the 1 should be associated with the concentration of MnO_4^-
		(iii) (C)	A solution of accurately/exactly/ precisely known concentration	1	
		(iii) (D)	Pipette	1	Not: Burette Accept graduated pipette.

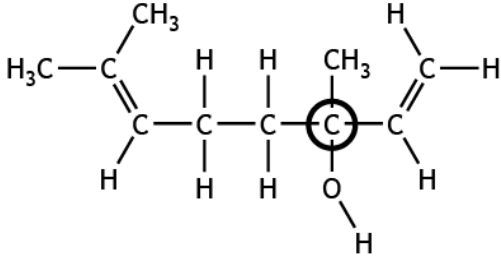| Question			Answer	Max mark	Additional guidance
	(c)		14mg, 14·06 mg, 0·01406 g	1	No units required. No mark can be awarded for correct answer if wrong unit is given. (wrong units would only be penalised once in the paper)
	(d)		24%, 24·3% Partial marks **1 mark** awarded for 30 g would contain 3·6 mg **1 mark** for $\dfrac{\text{any calculated mass}}{14\cdot 8}\times 100$	2	

Question	Answer	Max mark	Additional guidance
8.	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
9.	(a)	(i)	A drawing similar to Diagram shows **at least one** detergent molecule. All tails shown should be **fully** inside the fat-soluble dirt.	**1**	
		(ii)	hydrophobic	**1**	
	(b)	(i)	To break down coloured compounds/ removes stains/kill bacteria/kill fungi/inactivate viruses/germs	**1**	Stating only that oxidation occurs would be seen as restating the information from the stem. Discolour is not accepted.

Question			Answer	Max mark	Additional guidance
		(ii)	18 cm^3/0·018 litres **with correct unit** **Partial marking** 1 mark can be awarded for two of the three steps shown below correctly calculated: 1. number of moles of H_2O_2 2. mole ratio applied 3. calculated number of moles of O_2 multiplied by 24 (24000) If processed by proportion 68 g ←→ 24 l (24000 cm^3) 1 mark OR 0.051 g ←→ 0.036 l (36 cm^3) 1 mark **1 mark** for correct units.	3	 If an incorrect volume is calculated but the units of volume used are appropriate to the calculation then 1 mark would be awarded for correct units. Accept L for litres

Question			Answer	Max mark	Additional guidance
	(c)	(i)	amino acids	**1**	
		(ii) (A)	Amide/amide link/peptide link	**1**	Amine/amino not acceptable
		(ii) (B)	Any of the shown amino acids: 	**1**	

Question			Answer	Max mark	Additional guidance
		(iii) (A)	Denaturing	**1**	
		(iii) (B)	Temperature increase/pH	**1**	Temperature on its own is not acceptable. High/higher/above optimum temperature are also accepted.
	(d)	(i)	Condensation	**1**	
		(ii)		**1**	

Question			Answer	Max mark	Additional guidance
10.	(a)	(i)	40·23/40·2/40 (%)	**1**	
		(ii)	geranyl acetate/peak 5	**1**	
	(b)		2·7p/ 3p Partial marking 1 mark can be awarded for Evidence of scaling up to 500cm^3 eg 460mg of 1,8-cineole **OR** Evidence for determining a correct cost for a calculated mass of 1,8-cineole eg 0·92mg costs 0.00544 pence	**2**	
	(c)	(i)		**1**	
		(ii)	$C_{15}H_{24}$ OR $(C_5H_8)_3$	**1**	

[END OF MARKING INSTRUCTIONS]