National
Qualifications
2024

2024 Chemistry

Higher – Paper 2

Question Paper Finalised Marking Instructions

These marking instructions have been prepared by examination teams for use by SQA appointed markers when marking external course assessments.

General marking principles for Higher Chemistry

Always apply these general principles. Use them in conjunction with the detailed marking instructions, which identify the key features required in candidates' responses.

(a) Always use positive marking. This means candidates accumulate marks for the demonstration of relevant skills, knowledge and understanding; marks are not deducted for errors or omissions.

(b) If a 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.

(c) Do not award half marks.

(d) Where a candidate makes an error at an early stage in a multi-stage calculation, award marks for correct follow-on working in subsequent stages, unless the error significantly reduces the complexity of the remaining stages. Apply the same principle for questions that 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.

(e) Unless a numerical question specifically requires evidence of working to be shown, award full marks for a correct final response (including units) on its own.

(f) Candidates may fully access larger mark allocations whether their responses are in continuous prose, linked statements, or a series of developed bullet points.

(g) Do not deduct marks 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', are acceptable.

(h) 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.

(i) If a correct response is followed by a wrong response, award no marks. **For example** in response to the question, 'State the colour seen when blue Fehling's solution is warmed with an aldehyde', do not award marks for the response 'red green'. However, if a correct response is followed by additional information which does not conflict with that, ignore the additional information, 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** gain marks.

(j) Award full marks for the correct response to a calculation without working. Award partial marks, as shown in the detailed marking instructions, when working is given but the final response is incorrect. An exception is when candidates are asked to 'Find, by calculation' - do not award full marks for the correct response without working.

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

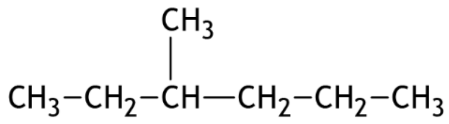
(l) Award marks for a symbol or correct formula in place of a name **unless stated otherwise in the detailed marking instructions.**

(m) When formulae of ionic compounds are given as responses, candidates only need 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, do not award marks.

(n) If an answer comes directly from the text of the question, do not award marks. **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. $C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(\ell)$. Name the kind of enthalpy change that the student measured', do not award marks 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

- Award the full mark for '3, methyl-hexane', although the punctuation is not correct.

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.

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.

- Award the full mark for a response such as 'the more Cl_2, the stronger the acid', although not completely correct.

(p) Unless the question is clearly about a non-chemistry issue, for example costs in an industrial chemical process, do not award marks for a non-chemical response.
For example, in response to the question, 'Why does the (catalytic) converter have a honeycomb structure?', do not award a mark for 'To make it work'. This response may be correct but it is not a chemical response.

(q) Only award marks for a valid response to the question asked. Where candidates are asked to:

- **identify, name, give** or **state**, they must 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, for example '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 chemistry to a new situation. A number of responses are acceptable: award marks for any suggestions that are supported by knowledge and understanding of chemistry.
- **use their 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). Candidates gain marks for the breadth and/or depth of their conceptual understanding.
- **write**, they must complete a chemical or word equation, for example 'Write the word equation for the complete combustion of ethanol.'

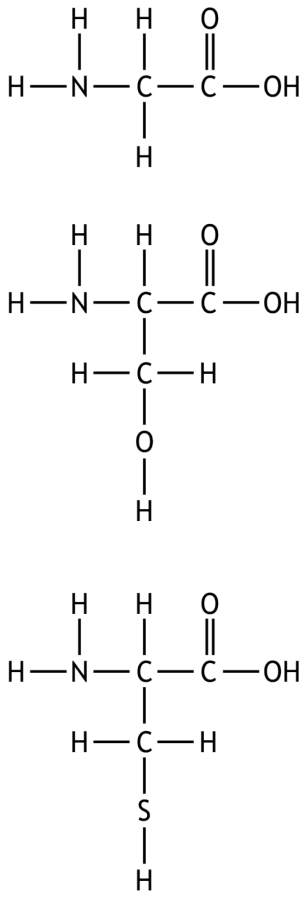
Marking instructions for each question

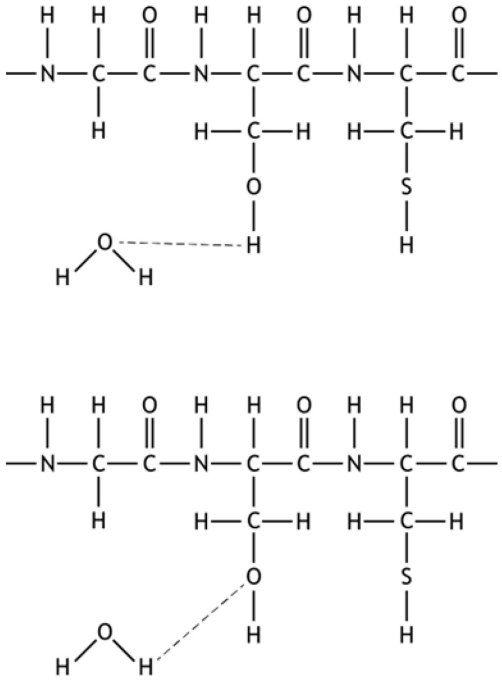
Question			Expected response	Max mark	Additional guidance
1.	(a)	(i)	(The first ionisation energy is) the energy required to remove one mole of electrons from one mole of gaseous atoms.	**1**	
		(ii)	$P(g) \rightarrow P^{+}(g) + e^{-}$	**1**	State symbols must be shown. Negative sign on electron not required.
	(b)		Stronger intermolecular/Van der Waals forces between phosphorus compared with nitrogen. **(1 mark)** London dispersion forces/LDFs are the intermolecular forces present. **(1 mark)** There are more electrons in phosphorus/P_4 compared to nitrogen/N_2. **(1 mark)**	**3**	Any mention of breaking covalent/ionic/metallic bonds is cancelling.
	(c)		230 (kJ mol^{-1}) **Partial marks:** (6 x 201) + (2 x (-)488) **(1 mark)** **OR** recognising that bond breaking is endothermic and bond making is exothermic. **(1 mark)**	**2**	-230 (kJ mol^{-1}) 1 mark No units required. (Wrong units would only be penalised once in any paper). (KJ mol^{-1} or Kj mol^{-1} or KJ mol^{-1} accepted).
	(d)	(i)	77/77.1(%) **Partial marks:** Calculates theoretical mass = 149.85 (g) **(1 mark)** **OR** Correctly calculates the number of moles of reactant (2.42) and product (1.21). **(1 mark)** **OR** Follow through from incorrectly calculated theoretical mass using relationship correctly. **(1 mark)**	**2**	
		(ii)	Reducing agent	**1**	

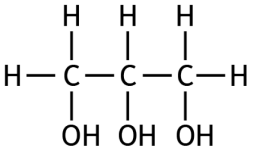
Question			Expected response	Max mark	Additional guidance
1.	(d)	(iii)	145 (litres) **Partial marks:** 280/28 = 10 **(1 mark)** **OR** 1450 divided by incorrectly calculated ratio **(1 mark)** **OR** 1450/280 = 5.18 **(1 mark)** **OR** Incorrectly calculated ratio x 28 **(1 mark)** **OR** by proportion 280 (g) = 1450 (l) **(1 mark)**	**2**	No units required. (Wrong units would only be penalised once in any paper).

Question			Expected response	Max mark	Additional guidance
2.	(a)	(i)	Activation energy	**1**	
		(ii)	(-)52.43, (-)52.4, (-)52 (kJ) Negative sign is not required	**1**	No units required. (Wrong units would only be penalised once in any paper). (KJ or Kj or KJ accepted). kJ mol^{-1} is not acceptable
		(iii)	-/1-/-1	**1**	The word negative is not accepted on its own.
	(b)		**10**Na + **2**KNO_3 → K_2O + **5**Na_2O + N_2	**1**	Or correct multiples
	(c)		Silicon dioxide is a covalent network **(1 mark)** (Strong) covalent bonds are broken **(1 mark)**	**2**	'Covalent lattice' is acceptable, but lattice on its own is not. Naming silicon as the covalent network is cancelling for first mark. Covalent network molecule is cancelling for first mark. A diagram of a molecule is cancelling for the first mark.
	(d)		47.26, 47.3, 47 (litres) OR 47260, 47300, 47000 ($cm^{3)}$ **(2 marks)** **Partial marks:** Correctly calculated number of moles of sodium azide multiplied by 1.6 to give number of moles of nitrogen eg moles of nitrogen = 1.969 **(1 mark)** **OR** An incorrectly calculated number of moles nitrogen x 24 **(1 mark)** **OR** by proportion 65 g → 38.4 l **(1 mark)** Allow follow through from incorrect multiple of 24 l **(1 mark)**	**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)
	(e)		(Powders) have larger/higher surface area **(1 mark)** More successful collisions **(1 mark)**	**2**	

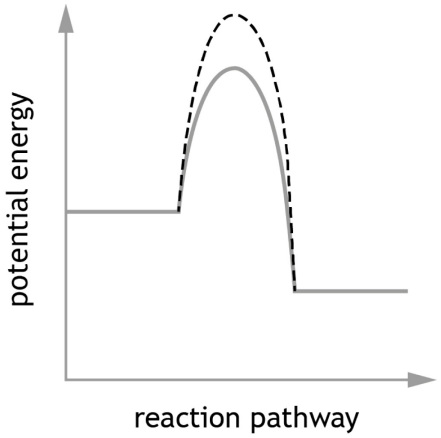
Question			Expected response	Max mark	Additional guidance
3.			**Award 1 mark** where the candidate has demonstrated, at an appropriate level, a limited understanding of the chemistry involved. They have made some statement(s) which are relevant to the situation, showing that they have understood at least a little of the chemistry within the problem. **Award 2 marks** where the candidate has demonstrated, at an appropriate level, a reasonable understanding of the chemistry involved. They make some statement(s) which are relevant to the situation, showing that they have understood the problem. **Award 3 marks** where the candidate has demonstrated, at an appropriate level, a good understanding of the chemistry involved. They show a good comprehension of the chemistry of the situation and provide 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. The answer does not need to be 'excellent' or 'complete' for the candidate to gain full marks. **Award 0 marks** where the candidate has not demonstrated, at an appropriate level, an understanding of the chemistry involved. There is no evidence that they have recognised the area of chemistry involved, or they have not given any statement of a relevant chemistry principle. Award this mark also if the candidate merely restates the chemistry given in the question.	**3**	

Question			Expected response	Max mark	Additional guidance
4.	(a)	(i)	Water	**1**	
		(ii)	Oxidation/condensation	**1**	Accept dehydrogenation
		(iii)	An amino acid that must be/is obtained from the diet/cannot be made in the body	**1**	
		(iv) (A)	Denaturing	**1**	Accept denature(s)/denatured.
		(iv) (B)	Any of the three correct amino acid structures 	**1**	All bonds and atoms must be correct to award this mark.

Question			Expected response	Max mark	Additional guidance
4.	(a)	(iv) (C)		**1**	If more than one hydrogen bond indicated, all must be correct. If partial charges are shown they must be correct.
	(b)	(i)	0.467/0.47	**1**	Ignore any units.
		(ii)	The spots for glycine and lysine overlap/are close together. **OR** The R_f values are similar/close together for glycine and lysine.	**1**	
		(iii)	Threonine	**1**	

Question			Expected response	Max mark	Additional guidance
5.	(a)		Fats are a concentrated source of energy **OR** Fats are essential for the transport/storage of fat-soluble vitamins in the body	**1**	
	(b)	(i)		**1**	Accept correct shortened structural formula.
		(ii)	Ester (link)	**1**	
	(c)		Fats are more saturated (with more regular shape). **(1 mark)** This means they can pack together more closely/more compact structure. **(1 mark)** Stronger LDF/forces of attraction between the molecules. **(1 mark)**	**3**	Accept correct answer in terms of oils.
	(d)	(i)	Rancid	**1**	
		(ii)	Bromine solution will quickly/rapidly decolourise with molecule B. **OR** Bromine solution will decolourise with molecule B but not molecule A **OR** Bromine solution will not decolourise with molecule A but will with molecule B.	**1**	
		(iii) (A)	Atoms or molecules with unpaired electron(s).	**1**	Accept species in place of atoms or molecules. If reference is made to a singular atom, electron must also be singular.
		(iii) (B)	Initiation	**1**	

Question			Expected response	Max mark	Additional guidance
5.	(d)	(iv) (A)	Can react with free radicals forming stable molecules.	**1**	Accept: Donates/provides electron(s) (to pair with an unpaired electron) **OR** Acts as a reducing agent
		(iv) (B)	Vitamin E is less polar (than vitamin C) **(1 mark)** An explanation that links solubility of vitamin E to the polarity of fats and oils **(1 mark)**	**2**	Accept response in terms of vitamin C.
	(e)	(i)	$C_{13}H_{27}COONa$ **OR** $C_{13}H_{27}COO^-Na^+$ **OR** $(C_{13}H_{27}COO^-)(Na^+)$	**1**	Accept structural formula. Bond between O and Na is cancelling.
		(ii)	To prevent scum forming	**1**	Accept an answer in terms of soap
		(iii) (A)	2-methylbuta-1,3-diene	**1**	Apply GMP (o).
		(iii) (B)	3	**1**	

Question			Expected response	Max mark	Additional guidance
6.	(a)	(i)	Methyl octanoate	**1**	
		(ii) (A)	Diagram shows a labelled safe method of heating (eg water/sand bath or heating mantle) and labelled reaction mixture. **(1 mark)** Diagram shows a labelled method of preventing the vapours escaping e.g. wet paper towel/small test tube of cold water/condenser at neck of test tube. **(1 mark)**	**2**	A closed system/stoppered test tube is not acceptable for the second mark.
		(ii) (B)		**1**	The peak drawn shows a higher activation energy. The line drawn by the candidate must start and finish at the same potential energies and positions on the reaction pathway.
	(b)	(i)	Correctly identifies that the molecule has two parts with different polarities. **(1 mark)** Correctly identifies that the polar part/hydroxyl groups dissolve in water/polar liquids/are hydrophillic whilst the non-polar part/hydrocarbon chain dissolve in biodiesel/non-polar liquids/are hydrophobic **(1 mark)** **OR** Correctly identifies that the molecule has two parts that are hydrophillic and hydrophobic. **(1 mark)** Correctly identifies that the hydrophillic part dissolves in water/polar liquids and the hydrophobic part dissolves in biodiesel/non-polar liquids **(1 mark)**	**2**	
		(ii)	Reacting (edible oils) with glycerol	**1**	

Question			Expected response	Max mark	Additional guidance
6.	(c)	(i)	**1 from:** Distance between burner/wick/flame and container Material/type of container Stirring water in both Size of wick Use same draught shield Indication of same insulation in both experiments	**1**	Distance from fuel to container is not accepted. Same mass of fuel is not accepted Same mass/volume of water is not accepted.
		(ii)	**1 from:** Use a draught shield Move flame closer to container Fit a lid on the container Insulate container	**1**	
		(iii)	(-)41.8 (kJ g^{-1}) (3 marks) If final answer is wrong a maximum of 2 marks for the following may be awarded: 1 mark for a demonstration of the correct use of the relationship Eh = cmΔT as shown by (4·18 x (an order of magnitude of 2) x 21) (ignore units for this mark). 1 mark for evidence of scaling up of a calculated value of energy released to 1 gram.	**3**	No units required. A maximum of 2 marks can be awarded for correct answer if wrong unit is given (where no unit required, wrong units would only be penalised once in any paper). kJ is acceptable in place of kJ g^{-1} (KJ or Kj or KJ g^{-1} or Kj g^{-1} accepted).
	(d)		£12.75	**1**	

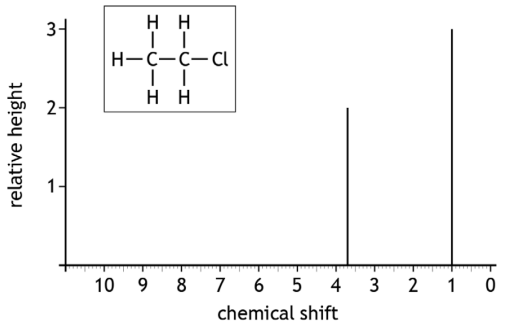
Question			Expected response	Max mark	Additional guidance
7.	(a)		19/19.4/19.37 (g l^{-1}) **Partial marks:** 19373.4 **(1 mark)** **OR** Correct conversion of incorrectly calculated value to g l^{-1} **(1 mark)**	**2**	Answer must be given in g $l^{-1.}$
	(b)	(i) (A)	Solution of accurately/precisely/ exactly known concentration	**1**	
		(i) (B)	Rinse with seawater/sample/solution **(1 mark)** Fill above the mark and allow liquid to drop down to the mark (and read from the bottom of the meniscus) **(1 mark)** **OR** Fill to mark, read from the bottom of the meniscus **(1 mark)**	**2**	Rinse with water is not accepted.
		(ii)	To identify the end point.	**1**	
		(iii) (A)	Only concordant values are used/(the titre for) sample 1 is not concordant.	**1**	
		(iii) (B)	0.5775 (mol l^{-1}) If incorrect answer given, a maximum of two marks can be awarded for demonstration of knowledge of the two concepts: 1 mark for knowledge of the relationship between moles, concentration and volume. 1 mark for application of mole ratio.	**3**	No units required. Only two marks can be awarded if wrong unit is given. (wrong units would only be penalised once in any paper).

Question			Expected response	Max mark	Additional guidance
7.	(b)	(iii) (C)	17.47 g **Partial marking:** Calculation of mass of chloride in 10 cm^3 sample = 0.1747 (g) **(1 mark)** **OR** multiplying calculated mass of chloride ions by 100 **(1 mark)** **OR** Calculation of total number of moles in 1 litre = 0.492 **(1 mark)** **OR** For multiplying calculated number of moles by 35.5 **(1 mark)**	**2**	No units required. Only one mark can be awarded if wrong unit is given. (wrong units would only be penalised once in any paper).
	(c)		Chloromethane has permanent dipole to permanent dipole interactions whereas water has hydrogen bonding. **(1 mark)** Hydrogen bonding is stronger than permanent dipole to permanent dipole interactions. **(1 mark)**	**2**	

Question			Expected response	Max mark	Additional guidance
8.			**Award 1 mark** where the candidate has demonstrated, at an appropriate level, a limited understanding of the chemistry involved. They have made some statement(s) which are relevant to the situation, showing that they have understood at least a little of the chemistry within the problem. **Award 2 marks** where the candidate has demonstrated, at an appropriate level, a reasonable understanding of the chemistry involved. They make some statement(s) which are relevant to the situation, showing that they have understood the problem. **Award 3 marks** where the candidate has demonstrated, at an appropriate level, a good understanding of the chemistry involved. They show a good comprehension of the chemistry of the situation and provide 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. The answer does not need to be 'excellent' or 'complete' for the candidate to gain full marks. **Award 0 marks** where the candidate has not demonstrated, at an appropriate level, an understanding of the chemistry involved. There is no evidence that they have recognised the area of chemistry involved, or they have not given any statement of a relevant chemistry principle. Award this mark also if the candidate merely restates the chemistry given in the question.	**3**	

Question			Expected response	Max mark	Additional guidance
9.	(a)	(i)	2843.55 (kg) **Partial marking:** 1 mark for moles Cl_2 required = 40050 moles **(1 mark)** **OR** Follow through for an arithmetically correct answer derived by multiplying a wrongly calculated number of moles **(1 mark)** **OR** **By proportion** 79.9(g) = (71 x 2) 142 (g) **(1 mark)** **OR** A correctly calculated mass of chlorine from an incorrect mole ratio **OR** Correct application of the mole ratio to an incorrectly calculated number of moles of TiO_2.	**2**	No units required. Only one mark can be awarded if wrong unit is given. (wrong units would only be penalised once in any paper).
		(ii)	Covalent molecular.	**1**	Accept discrete covalent molecular.
	(b)	(i)	20%/20.1%/20.08 % **Partial marking:** Correct use of atom economy relationship without correct use of stoichiometry (ie using 1 mole of Mg) (working must be shown) **(1 mark)** **OR** Correct use of atom economy relationship with correct use of stoichiometry (working must be shown) for magnesium chloride **(1 mark)** **OR** Correct retrieval of GFMs and use of stoichiometry. **(1 mark)** **OR** Correct working with no correct answer given. **(1 mark)**	**2**	

Question			Expected response	Max mark	Additional guidance
9.	(b)	(ii)	$Mg(s) \rightarrow Mg^{2+}(aq) + 2e^-$	**1**	Ignore state symbols. Negative sign on e not required. Accept double headed arrow. Accept correct multiples.
		(iii)	10854 (moles of magnesium) **Partial marking:** **Using moles:** Correct calculation of moles of titanium chloride = 10005 **and** moles magnesium = 30864 **(1 mark)** **OR** Correct application of mole ratio. eg 20010 moles magnesium requires 10005 moles titanium chloride (or any order of magnitude eg 20 or 10). **(1 mark)** Allow for follow through from calculated number of moles of magnesium minus a calculated number of moles derived from titanium chloride **(1 mark)**	**3**	
		(iv)	Argon is inert/unreactive	**1**	
	(c)		Can be carried out at lower temperature/requires less energy/ has a higher atom economy	**1**	

Question			Expected response	Max mark	Additional guidance
10.	(a)		6.0 - 4.5	**1**	
	(b)		Propanone/acetone	**1**	
	(c)			**1**	

[END OF MARKING INSTRUCTIONS]