National
Qualifications
2025

2025 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.

SQA ©

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.

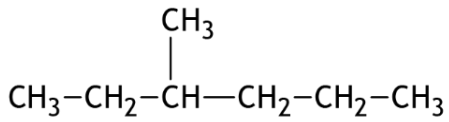
(l) Award marks for a symbol or correct formula in place of a name **unless stated otherwise in the detailed marking instructions.**

(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

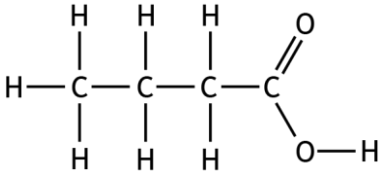
Question			Expected response	Max mark	Additional guidance
1.	(a)	(i)	$Na(g) \longrightarrow Na^{+}(g) + e^{-}$	**1**	State symbols must be shown, negative sign on electron not required.
		(ii)	1735 ($kJ\ mol^{-1}$)	**1**	No units required. No mark can be awarded for correct answer if wrong unit is given (where no unit required, wrong units would only be penalised once in any paper). kJ is acceptable in place of kJ mol−1 (KJ or Kj or KJ mol−1 or Kj mol−1 accepted).
		(iii)	The second ionisation energy (in sodium) involves removal of an electron from an (electron) shell that is inner/full/(more) stable/closer to the nucleus. **OR** Second electron is removed from an (electron) shell that is inner/full/(more) stable/closer to the nucleus. **(1 mark)** The second electron is less screened/the second (electron) shell is less screened. **OR** The second electron is more strongly attracted to/pulled towards the nucleus. **(1 mark)**	**2**	Correct statements made about the 2nd ionisation energy/electron of magnesium can also be credited as long as magnesium is named. Stating that the 2nd electron requires more energy than the 1st electron is not sufficient on its own. Shielding is acceptable in place of screening. Energy level is acceptable in place of electron shell. Increased attraction of the electron for the nucleus would be considered cancelling.
		(iv)	(They have the same number of occupied electron shells but) there are more protons/increased nuclear charge of the Mg^{2+} ion.	**1**	

Question			Expected response	Max mark	Additional guidance
1.	(b)	(i)	(Ionic bonds are) the electrostatic attraction between positive and negative ions. **OR** (An ionic bond is) the electrostatic attraction between oppositely charged ions.	**1**	Accept reference to a single ionic bond being the electrostatic attraction between a positive ion and a negative ion.
		(ii)	6 bananas (if working shown must be correct) **Partial marks** **----------** Mass of potassium in 7 day dose= $8 \times 7 \times 0.0012 \times 39.1 = 2.62752$ (g) **(1 mark)** Any calculated mass of potassium divided by 0.450. (**1 mark**)	**2**	2627.52 (mg) accepted for partial mark.

Question			Expected response	Max mark	Additional guidance
2.	(a)		**Bonding** **metallic** covalent **covalent** covalent **(1 mark)** **Structure** lattice **(covalent) network** molecular **(discrete) molecular/molecule** **(1 mark)**	**2**	**Covalent** lattice is accepted for (covalent) network.
	(b)	(i)	(The covalent radius) decreases.	**1**	
		(ii)	Argon does not form (covalent) bonds.	**1**	Argon is unreactive/monatomic is not accepted on its own.
	(c)		(van der Waals) forces increase/get stronger (going down the group). **(1 mark)** LDFs are the forces (broken between the atoms). **(1 mark)** The number of electrons increases (and so the stronger the forces). **(1 mark)**	**3**	Mention of increasing/stronger covalent/ionic/metallic bonds – cancels the first mark. This mark can only be awarded if no other forces are mentioned (as being broken). Mention of (breaking) bonds/forces between **molecules** cancels one mark.

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)	$C_3H_7OH + 4\frac{1}{2}\ O_2 \rightarrow 3CO_2 + 4H_2O$	**1**	Multiples not accepted.
		(ii)	-1050.04 (kJ mol^{-1}) **If incorrect answer given, a maximum of two partial marks can be awarded for demonstration of the two concepts:** 1 mark for a demonstration of the correct use of the relationship Eh = cmΔT as shown by (4.18 × (an order of magnitude 150) × 13.9). (ignore units for this mark). 1 mark for evidence of scaling up of a calculated value of energy released to one mole. This can be demonstrated by: • correct scaling of calculated Eh from 0.498 to 60 g • 0.498 g ⟷ Eh 60 g ⟷ $\frac{60 \times Eh}{0.498}$ • $\frac{0.498}{60}$ (0.0083) ⟷ Eh 1 ⟷ X	**3**	1050.04 (kJ mol^{-1}) **(2 marks)** No units required. 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 mol^{-1} (KJ or Kj or KJ mol^{-1} or Kj mol^{-1} accepted).
		(iii)	• balance • (alcohol) burner • (copper) can/beaker • thermometer • measuring cylinder/volume measurement • clamp stand/tripod/can suspension method Any four for 2 marks. Any two for 1 mark.	**2**	Bomb calorimeter worth maximum of 1 mark.
		(iv)	Heat/energy loss to the surroundings **OR** Incomplete combustion. **OR** Evaporation of alcohol/fuel.	**1**	Evaporation on its own is not sufficient.
	(b)	(i)	1:3 **OR** 2:6	**1**	Hydrogen:oxygen ratio accepted if labelled.

Question			Expected response	Max mark	Additional guidance
4.	(b)	(ii) (A)	Acidified (potassium/sodium) dichromate. **OR** Hot copper(II)oxide.	**1**	Copper(II)oxide without mention of heating is insufficient for the mark.
		(ii) (B)		**1**	Correct structure of 2-methylpropanoic acid is also accepted.
		(ii) (C)	Butanone/butan-2-one.	**1**	Structure not accepted.
	(c)	(i)	Volumetric/standard flask.	**1**	
		(ii) (A)	Rinse with sodium hydroxide (before filling).	**1**	
		(ii) (B)	20.4 (cm^3)	**1**	Units are not required but must be correct if given. (wrong units would only be penalised once in any paper).

Question			Expected response	Max mark	Additional guidance
4.	(c)	(ii) (C)	0.08316 ($moll^{-1}$) **If incorrect answer given, 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 sodium hydroxide solution e.g. 0·105 x 0.0198 = 2.079×10^{-3} moles. **OR** Calculation of concentration of ethanoic acid e.g. $2.079 \times 10^{-3} \div 0.025$ **OR** Insertion of correct pairings of values for concentration and volume in a valid titration formula If the relationship between moles, concentration and volume is used more than once, it must be used correctly every time. 1 mark for knowledge of relationship between moles of sodium hydroxide and ethanoic acid. This could be shown by one of the following steps: Calculation of moles ethanoic acid from moles sodium hydroxide i.e. calculated moles of sodium hydroxide used again to calculate concentration of ethanoic acid. **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 are not required but must be correct if given. (wrong units would only be penalised once in any paper)

Question			Expected response	Max mark	Additional guidance
4.	(c)	(iii) (A)	$CH_3COO^-K^+$	**1**	$K^+CH_3COO^-$ is also acceptable.
		(iii) (B)	5.4 (g)	**1**	Units are not required but must be correct if given. (wrong units would only be penalised once in any paper)

Question			Expected response	Max mark	Additional guidance
5.	(a)		(Sucrose) is polar due to its hydroxyl groups. **OR** (Sucrose) can form hydrogen bonds due to its hydroxyl groups. **(1 mark)** An explanation which links solubility of the molecule (sucrose) to the polarity of water/hydrogen bonding of water. **(1 mark)**	**2**	(-)OH accepted as hydroxyl. "Like dissolves like" on its own is not sufficient for the second mark.
	(b)	(i)	Tyr-Pro-Phe-Pro-Gly-Pro-Iso. **OR** Iso-Pro-Gly-Pro-Phe-Pro-Tyr.	**1**	
		(ii)	Essential (amino acid)	**1**	
	(c)	(i)	Ester(s)	**1**	Triglyceride accepted
		(ii) (A)	Glycerol/propane-1,2,3-triol	**1**	propan-1,2,3-triol accepted
		(ii) (B)	Palmitic acid	**1**	
		(iii)	Addition	**1**	Reduction accepted
	(d)	(i)	Ethanal	**1**	
		(ii)	Carbonyl	**1**	
		(iii) (A)	Diterpenoid	**1**	
		(iii) (B)	A correctly circled isoprene unit.	**1**	Including the OH is not accepted.
	(e)		3	**1**	

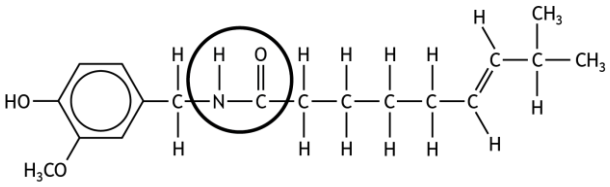
Question			Expected response	Max mark	Additional guidance
6.	(a)		$H_2O_2(aq) + 2H^+(aq) + 2e^- \rightarrow 2H_2O(\ell)$	**1**	Ignore state symbols. Charge on electron not required.
	(b)		$2S_2O_3^{2-}(aq) + I_2(aq) \rightarrow S_4O_6^{2-}(aq) + 2I^-(aq)$	**1**	Ignore state symbols.
	(c)	(i)	10	**1**	
		(ii)	To keep the concentration (of the reactants) constant. **OR** Adding water will change/affect/ dilute/decrease the concentration (of the reactants).	**1**	
	(d)	(i)	(As concentration doubles the rate of reaction) doubles.	**1**	
		(ii)	16.129 (s), 16.13(s)	**1**	Units are not required but must be correct if given. (wrong units would only be penalised once in any paper)
		(iii)	The more particles/ions (in a given volume). **(1 mark)** More successful collisions (and the faster the reaction). **(1 mark)**	**2**	

Question			Expected response	Max mark	Additional guidance
7.	(a)		1129.4 (kJ mol^{-1}) **Partial marks** ---------- Correctly retrieving 3 bond enthalpies from data book (243, 804, 338). **(1 mark)** Correct manipulation of incorrect bond enthalpies (must include the given ΔH = -107.6 kJ mol^{-1}). **(1 mark)**	**2**	Retrieval of a fourth bond enthalpy (ie 360 for CO) is not considered cancelling for the first mark. Units not required, but if stated must be correct. Incorrect units would only be penalised once per paper. kJ is acceptable in place of kJ mol^{-1} (KJ or Kj or KJ mol^{-1} or Kj mol^{-1} accepted).
	(b)		(Cooling favours) exothermic reaction. **(1 mark)** Cooling below 100 °C removes $H_2O(g)$ from equilibrium as $H_2O(\ell)$ **(1 mark)**	**2**	
	(c)	(i)	1 mark for workable apparatus showing reaction of hydrochloric acid with calcium carbonate. 1 mark for showing gas being passed through sealed container of sodium hydroxide.	**2**	Treat each mark and associated labels separately.
		(ii)	16.92/16.9/17(%) **Partial marks** ---------- Correct use of atom economy relationship without correct use of stoichiometry (working must be shown). **(1 mark)** Correct working with no correct answer given. **(1 mark)** Incorrect use of stoichiometry. Answer and working must be shown. **(1 mark)** 0·1692 **(1 mark)**	**2**	

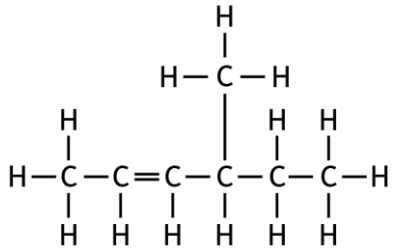
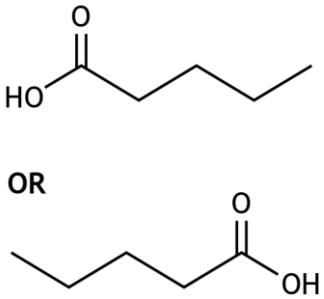
Question			Expected response	Max mark	Additional guidance
8.	(a)	(i)	198.4 (g) **Partial marks** --- Calculating number of moles of SnO_2 required (1.316). **(1 mark)** **OR** Calculating the theoretical mass of tin required to produce 100 g at 64% yield (156.25). **(1 mark)** **OR** Calculating mass of SnO_2 required for 100% yield (126.96). **(1 mark)** **OR** Follow through from an incorrectly calculated 100% yield. **(1 mark)**	**2**	
		(ii)	Carbon is in excess by 0.083 (moles). **Partial marks** --- Moles of SnO_2 = 0.167 AND moles of C = 0.25 **(1 mark)** **OR** Allow for follow through from correctly applying mole ratio and subtraction to calculated number of moles **(1 mark)** --- By proportion 25.2 ◄► 2.007 grams **(1 mark)** **OR** Allow for follow through from calculated mass of excess carbon converted to moles. **(1 mark)**	**2**	A **maximum of 1 mark** can be awarded if carbon is not stated as being the reactant in excess. **1 mark** can be awarded for identification of tin(IV) oxide as the reactant in excess if supported by candidates working.

Question			Expected response	Max mark	Additional guidance
8.	(a)	(iii)	49.92 (g) **Partial marks** --- Calculating moles of CO_2 **(1 mark)** Correctly applying mole ratio to work out a mass for an incorrect number of moles. **(1 mark)** --- By proportion 150.7 g ◄► 80 litres **(1 mark)**	**2**	
	(b)	(i)	Filtration	**1**	
		(ii)	Seawater is a free/cheap raw material. **OR** Calcium chloride can be sold as a by product.	**1**	

Question			Expected response	Max mark	Additional guidance
9.	(a)	(i)	Propagation	**1**	
		(ii)	An (unpaired) electron	**1**	Do not accept electrons.
	(b)		Denaturing	**1**	
	(c)		Cosmetics/food products/plastics	**1**	
	(d)	(i)	Oxygen/gas is escaping	**1**	
		(ii)	Two from: • mass/volume/surface area/size of potato discs • concentration of H_2O_2 • temperature (of H_2O_2 or pH solution)	**2**	Either from • type/variety of potato, or • (discs from the) same potato Accepted for 1 mark Weight is accepted for mass (of potato discs).
		(iii)	As the pH increases the rate (of reaction) increases up to pH 10/ reaches a maximum/optimum at pH 10 (and then decreases). **OR** As the pH increases the rate (of reaction) increases and then decreases.	**1**	Rate must be mentioned.

Question			Expected response	Max mark	Additional guidance
10.	(a)	(i)	 capsaicin (CAP)	**1**	
		(ii)	Bromine solution would quickly/rapidly decolourise with CAP/capsaicin. **OR** Bromine solution will decolourise with CAP/capsaicin but not with DHC/ dihydrocapsaicin. **OR** Bromine solution will not decolourise with DHC/dihydrocapsaicin but will with CAP/capsaicin.	**1**	
	(b)		One from: • Capsaicinoids do not dissolve/are (relatively) insoluble in water • Capsaicinoids are hydrophobic • Capsaicinoids are non-polar	**1**	An answer referring to a named capsaicinoid is accepted. It/they is taken as referring to capsaicinoid.
	(c)		135 (s)	**1**	2.25 minutes is not accepted Sec(s) is not accepted as unit.
	(d)		3(p) **Partial marks** --- Mass of CAP in cream = 0.015 (g). **OR** Evidence of a calculated mass of CAP × (£)1.93/193(p). **OR** 60 g of CAP costs £115.82 **OR** 0.025% of a calculated cost of 60 g CAP **OR** $\frac{60}{1000}$ x £48.26	**2**	£0.03 is accepted. Rounding of the final answer to the nearest correct monetary unit.
	(e)		$C_6H_8O_6 \rightarrow C_6H_6O_6 + 2H^+ + 2e^-$	**1**	State symbols are not required, but if shown must be correct. Negative sign on electron not required.

Question			Expected response	Max mark	Additional guidance
11.			**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
12.	(a)		2,7-dimethyloctane	**1**	
	(b)			**1**	Any correct structure for 4-methylhex-2-ene
	(c)		 **OR**	**1**	

[END OF MARKING INSTRUCTIONS]