National
Qualifications
2025

2025 Chemistry

Advanced Higher

Question Paper Finalised Marking Instructions

General marking principles for Advanced 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) 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 of partial marks.

(e) In many cases, marks can still be awarded 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.

(f) If a correct answer and a wrong answer are present, 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 and additional information, which does not conflict, are present, 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.

(g) 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 '*Clearly show your working for the calculation*', when full marks cannot be awarded for the correct answer without working.

(h) Significant figures.

This marking instruction only applies to correct final answers. If the data in a question is given to three significant figures, the final answer should also have three significant figures. However one fewer significant figure and up to two more significant figures is acceptable.

For example if a correct final answer is 8.16 J then 8.2 J, 8.158 J and 8.1576 J would also be acceptable. Answers out with this range would not be acceptable and one mark would not be awarded.

The use of a recurrence dot, eg $0.\dot{6}$, would imply an infinite number of significant figures and would therefore not be acceptable.

This marking instruction must only be applied a maximum of once per paper and cannot be applied if instruction **(i)** has already been applied in the paper.

(i) Units

This marking instruction only applies to correct final answers. In most questions units are not required. However, if the candidate writes units then they must be correct. The symbols L and l are both acceptable for litres.
An incorrect unit would not be acceptable and one mark would not be awarded.

This marking instruction must only be applied a maximum of once per paper and cannot be applied if instruction **(h)** has already been applied in the paper.

(j) Intermediate rounding.

Ideally, calculated intermediate values should not be rounded. However, if the candidate has correctly rounded, the calculated intermediate values can have one significant figure fewer than the data given in the question but no fewer, otherwise full marks may not be awarded and partial marking would apply.
For example, if the data in a question is given to three significant figures, the intermediate value should have no fewer than two significant figures.

(k) If a structural formula is asked for, CH_3 is acceptable as a methyl group, and CH_3CH_2 and C_2H_5 are acceptable as an ethyl group.

If a name is asked for such as 3-methylhexane, then 3, methyl-hexane would be acceptable, ie ignore incorrect use of commas and dashes.

(l) When drawing structural formulae, a mark should only be awarded if the bonds point to the appropriate atoms.
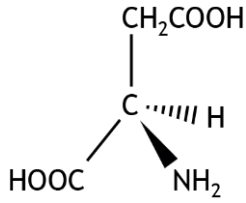
The example below would be incorrect.
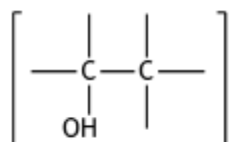
Marking instructions for each question

Section 1

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

Section 2

Question			Expected response	Max mark	Additional guidance
1.	(a)		(Molecules that are) non-superimposable mirror image(s).	**1**	
	(b)		**OR** A structure with two groups swapped with same wedged and dashed bonds. **OR** Any other correct structure.	**1**	Must be 3D. Connectivity and subscripts must be correct.
	(c)		Rotate by same amount/angle in opposite/different directions.	**1**	
	(d)		Racemic (mixture)	**1**	

Question			Expected response	Max mark	Additional guidance
2.	(a)		Side on overlap of (unhybridised p) orbitals.	**1**	Overlap of molecular orbitals is not an acceptable answer.
	(b)	(i)	The more hydroxyl/hydroxy/OH groups the stronger the acid. **OR** If the alkyl/methyl/ethyl/carbon chain group is on carbon number 4 position the acid is stronger (than if it is on carbon number 2 position). **OR** The longer the alkyl group/carbon chain the stronger the acid. **OR** Ethyl phenols are stronger than methyl phenols. **OR** The presence of an alkyl/methyl/ethyl group lowers the strength.	**1**	The opposite of each statement is also acceptable. Answers in terms of pK_a without referring to acid strength are not acceptable. Hydroxide or OH⁻ are not acceptable.
		(ii)	2.77×10^{-6} (mol l⁻¹) **(3)** Partial marking Up to two marks can be awarded for pH = ½pK_a – ½log c/correct substitution. **OR** Correct calculation of pH = 5.56 **OR** Calculation of [H_3O^+] using a calculated pH value. **OR** K_a = 5.13x10⁻¹¹ **OR** [H_3O^+] = $\sqrt{(K_a\, c)}$	**3**	2.8/2.774/2.7736 x10⁻⁶ (mol l⁻¹) are also acceptable answers. Unit not required but must be correct, if given.
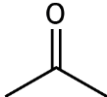
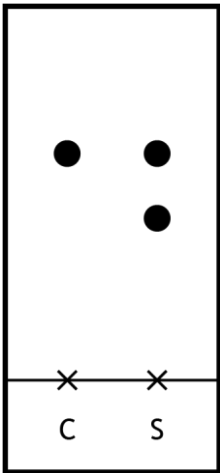| Question			Expected response	Max mark	Additional guidance
2.	(c)	(i)	Absorbs higher energy/shorter wavelength/higher frequency. **OR** Changes from absorbing yellow-green to green-blue/560-580 nm to 480-490 nm. **OR** There is a larger energy gap between HOMO and LUMO. **(1)** Fewer atoms/electrons/bonds in the conjugated system. **OR** Shorter/smaller conjugated system. **OR** Conjugation decreases. **(1)**	**2**	An answer referring to emission is cancelling for the first mark.
		(ii)	4.1 – 6.1 **OR** 5.1± 1	**1**	4-6/4.10-6.10/4.102-6.102 are also acceptable answers. 5/5.10/5.102± 1 are also acceptable answers.

	Question		Expected response	Max mark	Additional guidance
3.	(a)		Gravimetric (analysis)	**1**	
	(b)		Add (more) silver nitrate(solution). **OR** Excess silver nitrate (solution). **OR** Test with silver nitrate (solution).	**1**	Any mention of testing the precipitate is not an acceptable answer.
	(c)		19.3 (g l^{-1}) **(2)** Partial marking One mark can be awarded for: 0.19285g/0.00543 moles of chloride ions in the 20cm^3 sample titrated. **OR** Incorrectly calculated mass or moles of chloride ions in 20cm^3 sample multiplied by 100.	**2**	19/19.28/19.285 are also acceptable answers. Units are not required but must be correct if given.

Question			Expected response	Max mark	Additional guidance
4.	(a)	(i) (A)	H — C — C⊕ structural formula with H atoms	1	Positive charge must be on the correct carbon atom. Any type of structural formula is acceptable.
		(i) (B)		1	

Question			Expected response	Max mark	Additional guidance
4.	(a)	(ii) (A)	Entropy of surroundings is increasing. **OR** Total entropy (of system and surroundings) is increasing. **OR** Reaction is exothermic/ΔH is negative. **OR** Heat energy is released.	1	Total entropy of the system is increasing is not an acceptable answer.
		(ii) (B)	-80 (kJ mol⁻¹)	1	Units not required but if included they must be correct.
		(ii) (C)	610(K) **(2)** Partial marking One mark can be awarded for: T=ΔH/ΔS **OR** ΔG = 0	2	600/606/606.1(K) are also acceptable answers. Allow follow through from (ii)(B). Units not required but if included they must be correct.
	(b)	(i)	More stable/stabilisation. **OR** The intermediate for the minor product is less stable.	1	The product is more stable is not an acceptable answer.

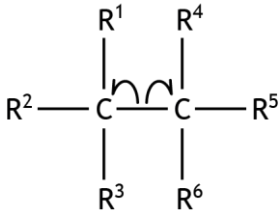|	Question		Expected response	Max mark	Additional guidance
4.	(b)	(ii)	This is an open-ended question **1 mark:** The candidate has demonstrated, at an appropriate level, a limited understanding of the chemistry involved. They have made some statement(s) that are relevant to the situation, showing that they have understood at least a little of the chemistry within the context. **2 marks:** The candidate has demonstrated, at an appropriate level, a reasonable understanding of the chemistry involved. They make some statement(s) that are relevant to the situation, showing that they understand the context. **3 marks:** The maximum available mark would be awarded to a candidate who has demonstrated, at an appropriate level, a good understanding, of the chemistry involved. The candidate 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 context. The answer does not need to be 'excellent' or 'complete' for the candidate to gain full marks.	3	**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 zero marks also if the candidate merely restates the chemistry given in the question.

Question			Expected response	Max mark	Additional guidance
5.	(a)	(i)	C_5H_6OS	**1**	Any order. C_5H_5OSH is not an acceptable answer.
		(ii)	$[SH]^+$ **OR** $[S{-}H]^+$ **OR** ^+SH	**1**	Positive charge must be shown on ion fragment. If no bracket + charge must be on the S atom.
	(b)	(i)	(aldehyde/ketones) C=O/carbonyl (stretch).	**1**	Reference to C=O in any other functional group is not an acceptable answer.
		(ii) (A)	 Any structural formula for propanone.	**1**	
		(ii) (B)	3	**1**	
	(c)	(i)	O = 0.53(g) **(2)** Partial marking 1 mark can be awarded for: Correct moles of CO_2 (0.0334) and H_2O (0.0333) **OR** Correct mass of C (0.401) and H (0.0667) **OR** A combination of the above two options that includes a correct value for C/CO_2 and H/H_2O **OR** Correctly calculated mass of O from incorrect mass of C and/or H (1−(mass of C+mass of H))	**2**	0.5/0.532/0.5324 are also acceptable answers. Units not required but if included they must be correct.
5.		(ii)	CH_2O	**1**	Allow follow through from (c)(i)

	Question		Expected response	Max mark	Additional guidance
5.	(d)	(i)	All four of the following steps in the order: • shake/mix/invert in a separating funnel • leave to separate/settle (into layers) • drain/remove/run off (lower) layer • Repeat (extraction with fresh dichloromethane)/add more dichloromethane	**2**	2 marks awarded for all 4 points. 1 mark awarded for 2 or 3 points. 0 marks awarded for 1 point. Maximum of 1 mark if separating funnel is not mentioned.
		(ii)	9.71 **(2)** Partial marking 1 mark may be awarded for: identifying 0.014g (in the other layer). **OR** Calculating K using 0.150g as the mass of caffeine in the aqueous layer = 0.9067 **OR** Calculating K by dividing 0.136 by an incorrectly calculated mass of caffeine in the aqueous layer.	**2**	9.7/9.714/9.7143 are also acceptable answers.
		(iii)	Diagram showing one spot matching pure caffeine and something indicating the presence of at least one other substance (must be in line vertically), for example, 	**1**	

	Question		Expected response	Max mark	Additional guidance
6.	(a)	(i)	25 cm^3/0.025 l **(1)** Use of pipette/burette. **AND** Making up to the mark/line (with deionised/distilled water/acid). **(1)**	**2**	Appropriate units are required. Adding rinsings from the pipette is cancelling for the second mark.
		(ii)	66 (mg) **(3)** Partial marking Up to 2 marks may be awarded for any two of the following: Correctly calculating moles of MnO$_4^-$ = 1.18 × 10^{-4} **OR** Correct application of 1:5 mole ratio. **OR** Correctly calculating a mass of iron in sample from a calculated moles of iron(II). **OR** Multiplying a calculated moles or mass of iron by 10	**3**	70/65.8/65.84 are also acceptable answers. Units not required but if included they must be correct.
		(iii)	The chloride (ion)/Cl$^-$ would be oxidised (by the potassium permanganate). **OR** (Potassium) permanganate acts as an oxidising agent. **OR** A redox reaction takes place.	**1**	

Question			Expected response	Max mark	Additional guidance
6.	(b)	(i)	Purple/380-400 nm/complementary colour to green is absorbed. **(1)** Electrons move to higher energy d orbitals. **(1)**	**2**	Any mention of emission or dropping energy levels is cancelling for the first mark. The second mark may not be awarded if the candidate refers to HOMO-LUMO.
		(ii)	The water ligand/water in complex/OH_2 donates a proton/H^+ **OR** The water ligand/water in complex/OH_2 acts as an acid. **AND** The water molecule/water solvent/H_2O accepts a proton/H^+ **OR** The water molecule/water solvent/H_2O acts as a base.	**1**	

Question			Expected response	Max mark	Additional guidance
7.	(a)		Carbon dioxide/CO_2/correct structure.	**1**	
	(b)	(i)	1.03×10^{-4} (mol l^{-1}) **(2)** Partial marking 1 mark can be awarded for: Application of 29.5% or 70.5% **OR** Dividing a mass in grams by 197 **OR** Dividing a calculated number of moles or a calculated mass by 4.35 litres.	**2**	$1.0/1.028/1.0284 \times 10^{-4}$ are also acceptable answers. Units not required but if included they must be correct.
		(ii) (A)	(enzyme) inhibitor	**1**	Antagonist is not an acceptable answer.
		(ii) (B)	6/six	**1**	

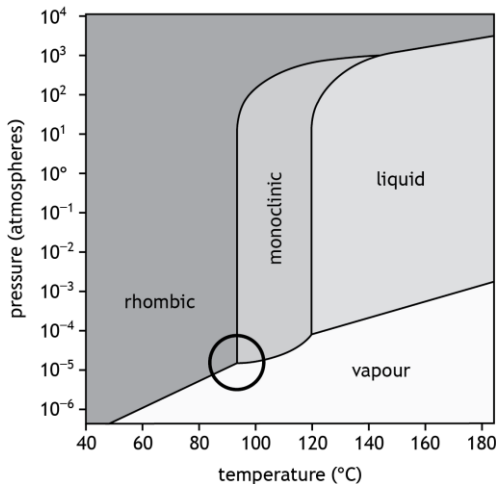|	Question		Expected response	Max mark	Additional guidance
8.	(a)		254 (kJ mol^{-1}) **(2)** Partial marking 1 mark can be awarded for: $c=f\lambda$ and $E = Lhf$ **OR** $E = \dfrac{Lhc}{\lambda}$ **OR** Use of the correct equations.	2	250/254.2/254.22 are also acceptable answers. Units not required but if provided they must be correct.
	(b)	(i)		1	Additional curly arrows are cancelling.
		(ii)	(Complex) mixture of products (formed) **OR** Many products (formed). **OR** Side reactions.	1	
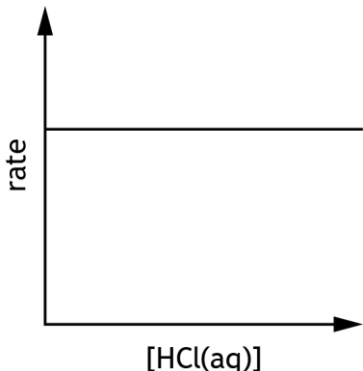
Question			Expected response	Max mark	Additional guidance
9.			This is an open-ended question **1 mark:** The candidate has demonstrated, at an appropriate level, a limited understanding of the chemistry involved. They have made some statement(s) that are relevant to the situation, showing that they have understood at least a little of the chemistry within the context. **2 marks:** The candidate has demonstrated, at an appropriate level, a reasonable understanding of the chemistry involved. They make some statement(s) that are relevant to the situation, showing that they understand the context. **3 marks:** The maximum available mark would be awarded to a candidate who has demonstrated, at an appropriate level, a good understanding, of the chemistry involved. The candidate 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 context. The answer does not need to be 'excellent' or 'complete' for the candidate to gain full marks.	**3**	**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 zero marks also if the candidate merely restates the chemistry given in the question.

Question			Expected response	Max mark	Additional guidance
10.	(a)	(i)	0.904 l/904 cm^3 **(2)** Partial marks 1 mark can be awarded for: Application of the mole ratio (1:2) **OR** Multiplying a calculated number of moles by 49 **OR** 0.0112 mol l^{-1} NaCN **OR** A calculated mass of NaCN x 100/0.0550	2	0.90/0.9045/0.90448 l **OR** 900/904.5/904.48 cm^3 are also acceptable answers. Units are required and must be appropriate for the values given.
		(ii) (A)	(The total) number of bonds (from the ligands) to the metal (ion)/central atom. **OR** Number of bonds the metal (ion)/central atom forms. **OR** Number of pairs of electrons donated/shared (from the ligands) to the metal (ion)/central atom.	1	
		(ii) (B)	Dicyanidoaurate(I)	1	
	(b)	(i)	Reduction	1	
		(ii)	All four of the following steps in the order: • filter • wash • dry/heat • to constant mass	2	2 marks awarded for all 4 points. 1 mark awarded for 2 or 3 points. 0 marks awarded for 1 point.

Question			Expected response		Max mark	Additional guidance
10.	(b)	(iii)	50.8 (kg)	**(2)**	**2**	51/50.83/50.832 are also acceptable answers.
			Partial marks 1 mark can be awarded for: Correct application of 91.5%			Units are not required but if provided must be correct.
			OR			
			21.5 ppm = 21.5 mg in 1 kg			
			OR			
			1/0.0215 = 46.5kg			

	Question		Expected response	Max mark	Additional guidance
11.	(a)	(i)	Lithium aluminium hydride/LiAlH$_4$	**1**	Formula must be correct if given.
		(ii)	Oxidation	**1**	
		(iii)	OR OR Any other correct structural formula.	**1**	
	(b)	(i) (A)		**1**	Either alpha hydrogen circled.
		(i) (B)	OR Any other correct structural formula.	**1**	
		(ii) (A)	OR Any other correct structural formula.	**1**	

Question			Expected response	Max mark	Additional guidance
11.	(b)	(ii) (B) (I)	Two different alpha hydrogen atoms/alpha hydrogen atoms present on different positions. **OR** Butanone is asymmetrical. **OR** Two different intermediates formed. **OR** Intermediates formed have different stabilities.	**1**	
		(ii) (B) (II)	5-hydroxy-5-methylheptan-3-one	**1**	

	Question		Expected response	Max mark	Additional guidance
12.	(a)	(i)	1/1st order	**1**	
		(ii)	Any horizontal line. 	**1**	
		(iii)	Rate = k[Na$_2$S$_2$O$_3$(aq)]	**1**	State symbol not required but must be correct if given. Must have square brackets. Must have lower case k. R/r is not acceptable in place of rate. Allow follow through from (a)(i).
		(iv)	0.131 **(1)** s^{-1} **(1)**	**2**	0.13 is also an acceptable answer. Allow follow through from (a)(iii). General marking principle **(i)** does not apply to this question.
	(b)	(i)	(Solid) monoclinic	**1**	
		(ii) (A)		**1**	Circled part must include all three states and cannot overlap with the liquid state.
		(ii) (B)	Rhombic, vapour and liquid (any order).	**1**	

[END OF MARKING INSTRUCTIONS]