CAMBRIDGE
International Education

Cambridge International AS & A Level

CHEMISTRY **9701/42**

Paper 4 A Level Structured Questions **October/November 2024**

MARK SCHEME

Maximum Mark: 100

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the October/November 2024 series for most Cambridge IGCSE, Cambridge International A and AS Level components, and some Cambridge O Level components.

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Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptions for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

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GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Science-Specific Marking Principles

1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
3	Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).
4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.
5	‘List rule’ guidance For questions that require ***n*** responses (e.g. State **two** reasons …): • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked *ignore* in the mark scheme should not count towards ***n***. • Incorrect responses should not be awarded credit but will still count towards ***n***. • Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response. • Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science.

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6 Calculation specific guidance

Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'.

For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values.

For answers given in standard form (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient (a) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme.

Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.

7 Guidance for chemical equations

Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme.

State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

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Question	Answer	Marks
1(a)(i)	Change in concentration = 0.135 [1] 0.135 / 1800 = 7.5×10^{-5} [1]	**2**
1(a)(ii)	Rate = k[X] [1]	**1**
1(a)(iii)	k = 0.693 / $t_{½}$ / k = 0.693 / 900 / k = ln2 / $t_{½}$ / k = ln2 / 900 / $t_{½}$ = ln2 / k [1]	**1**
1(a)(iv)	1.16×10^{-4} [1] mol dm^{-3} s^{-1} [1]	**2**
1(b)(i)	Any **two** from: • variable oxidation state • vacant / empty / unfilled d orbitals [1] • can form dative bonds / can accept electrons	**1**
1(b)(ii)	Iron **AND** iron is solid, reactants are gases **OR** catalyst and reactants are in different phases / states [1]	**1**
1(b)(iii)	Two for one mark, three for two marks: • adsorption of reactants by Pt • bonds of reactants weaken [1] • desorption of products [1]	**2**
1(b)(iv)	$NO_2 + SO_2 \rightarrow NO + SO_3$ **AND** $2NO + O_2 \rightarrow 2NO_2$ [1]	**1**
1(c)	BiO^+ [1] $3H_2SO_3 + 2BiO^+ + H_2O \rightarrow 3SO_4^{2-} + 8H^+ + 2Bi$ [1] 0.11 V [1]	**3**

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Question	Answer	Marks
2(a)	ΔH_{hyd} increases from left to right due to increase in charge [1] ionic radius decreases from left to right [1] causing increased attractive force to water molecules [1]	**3**
2(b)(i)	Mg^{2+} (aq) + $2Cl^-$ (aq) [1]	**1**
2(b)(ii)	Enthalpy change of hydration of magnesium ions and chloride ions [1] $\Delta H_{hyd}Mg^{2+} + 2\Delta H_{hyd}Cl^-$ [1]	**2**
2(b)(iii)	Selects 155, 1920 and 364 only [1] 2×364 [1] answer **–**2493 [1]	**3**
2(c)	The number of arrangements of the particles and of the energy in the system [1]	**1**
2(d)	$\Delta G = \Delta H - T\Delta S$ [1] answer +10.5 [1]	**2**
2(e)(i)	No, ΔG is positive [1]	**1**
2(e)(ii)	Becomes more / soluble **because** ΔG becomes more negative / less positive / smaller / closer to zero [1]	**1**

Question	Answer	Marks
3(a)(i)	$[H^+] = 10^{-12.35}$ **OR** $[H^+] = 4.47 \times 10^{-13}$ [1] K_w / 4.47×10^{-13} [1] **OR** pOH = 1.65 [1] $[OH^-] = 10^{-1.65}$ [1]	**2**
3(a)(ii)	$K_{sp} = (0.0112)(0.0224)^2$ **OR** $K_{sp} = [Ca^{2+}][OH^-]^2$ [1] answer 5.62×10^{-6} [1] $mol^3\,dm^{-9}$ [1]	**3**

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Question	Answer	Marks
3(a)(iii)	white solid / white ppt **AND** pH between 7.01 and 12.34 [1] common ion effect [1] hydroxide removed by precipitation **OR** ppt is $Ca(OH)_2$ [1]	**3**
3(a)(iv)	lattice energy and hydration energy greater for $CaSO_4$ **OR** lattice energy and hydration energy decrease down group [1] hydration energy decreases more / is dominant factor [1] enthalpy of solution is more endothermic for $BaSO_4$ **OR** is more endothermic down grp [1]	**3**
3(b)(i)	$Ca + 2CH_3COOH \rightarrow Ca(CH_3COO)_2 + H_2$ [1]	**1**
3(b)(ii)	Pair 1: CH_3COOH and CH_3COO^- [1] Pair 2: H_3O^+ and H_2O **OR** H_2O and OH^- [1]	**2**
3(b)(iii)	$\frac{[H^+][CH_3COO^-]}{[CH_3COOH]}$ [1]	**1**
3(b)(iv)	$[CH_3COO^-] = 0.788$, $[CH_3COOH] = 0.270$ $[H^+] = 5.96 \times 10^{-6}$ [1] pH = 5.22 [1]	**2**
3(b)(v)	$CH_3COO^- + H^+ \rightarrow CH_3COOH$ **OR** $Ca(CH_3COO)_2 + 2H^+ \rightarrow 2CH_3COOH + Ca^{2+}$ [1] $CH_3COOH + OH^- \rightarrow CH_3COO^- + H_2O$ [1]	**2**

Question	Answer	Marks
4(a)(i)	red/pink blue [1]	**1**
4(a)(ii)	$[Co(H_2O)_6]^{2+} + 2OH^- \rightarrow Co(H_2O)_4(OH)_2 + 2H_2O$ [1]	**1**
4(a)(iii)	acid-base [1]	**1**
4(b)(i)	$[CoL_2]^{2+}$ [1]	**1**

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Question	Answer	Marks
4(b)(ii)	+2 [1]	**1**
4(b)(iii)	2 3 [1]	**1**
4(b)(iv)	Not of the same **energy** / have different **energy** [1]	**1**
4(c)(i)	$5Fe^{2+} + MnO_4^- + 8H^+ \rightarrow 5Fe^{3+} + Mn^{2+} + 4H_2O$ [1]	**1**
4(c)(ii)	$0.02 \times 18.7/1000 = 3.74 \times 10^{-4}$ [1] $3.74 \times 10^{-4} \times 5 = 1.87 \times 10^{-3}$ [1]	**2**
4(c)(iii)	$1.87 \times 10^{-3} \times 10 = 1.87 \times 10^{-2}$ $4.18/1.87 \times 10^{-2} = 224 / 223.5(294)$ [1] $n = 2$ [1]	**2**

Question	Answer	Marks
5(a)	$K_{stab} = \frac{[[Ni(en)_3]^{2+}]}{[Ni^{2+}][en]^3}$ **OR** $\frac{[[Ni(en)_3]^{2+}]}{[Ni(H_2O)_6{}^{2+}][en]^3}$ [1]	**1**
5(b)(i)	$[Ni(en)_3]^{2+}$ **AND** larger K_{stab} **OR** more stable [1]	**1**
5(b)(ii)	$[Ni(H_2O)_6]^{2+} + 3en \rightarrow [Nien_3]^{2+} + 6H_2O$ [1]	**1**

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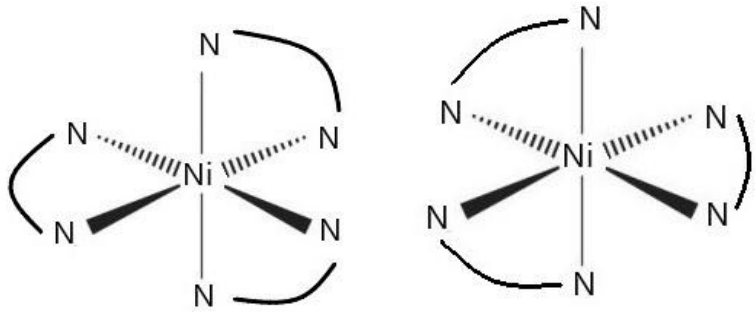
Question	Answer	Marks
5(c)	 octahedral with correct 3D for one $[Ni(en)_3]^{2+}$ [1] second optical isomer [1] optical isomerism [1]	**3**

Question	Answer	Marks
6(a)(i)	C*l*OCCOC*l* [1]	**1**
6(a)(ii)	PCl_3 / PCl_5 [1]	**1**
6(b)	oxygen [1] acidified $KMnO_4$ [1]	**2**
6(c)	C=O are electron withdrawing / electronegative [1] weakens O–H bond **OR** stabilises anion [1]	**2**
6(d)(i)	 [1]	**1**
6(d)(ii)	step 1: CH_3Cl + $AlCl_3$ [1] step 2: hot alkaline $KMnO_4$ [1]	**2**

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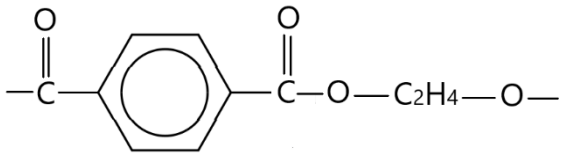
Question	Answer	Marks
6(d)(iii)	 correctly displayed ester linkage [1] rest of structure [1]	**2**
6(d)(iv)	condensation **AND** ester [1]	**1**

Question	Answer	Marks
7(a)	aluminium chloride **OR** $AlCl_3$ [1]	**1**
7(b)(i)	delocalised system / delocalised ring / pi system / pi ring [1] C–Cl bond [1]	**2**
7(b)(ii)	C–H bond [1] delocalised system / delocalised ring / pi system / pi ring [1]	**2**
7(c)	0, 5, 1 [1]	**1**
7(d)	$C_6H_6 + Cl_2 \rightarrow C_6H_5Cl + HCl$ [1]	**1**
7(e)	Cl^+ hydrogen / H chlorine / Cl [1]	**1**
7(f)(i)	nucleophilic substitution **AND** ethanol [1]	**1**
7(f)(ii)	delocalisation of LP of Cl with π system [1] C–Cl bond is stronger in chlorobenzene / partly double [1]	**2**

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Question	Answer	Marks
8(a)	biological activity [1]	**1**
8(b)	rotates plane polarised light 5.0° in anticlockwise direction [1]	**1**
8(c)	enantiomers [1]	**1**
8(d)	racemic [1]	**1**
8(e)	use of chiral catalyst [1]	**1**
8(f)	CH_2 and CH only in column one [1] CH_2 gives a doublet, CH gives a triplet [1] doublet due to 1 proton on neighbouring carbons triplet due to 2 protons on neighbouring carbons [1]	**3**
8(g)	5 [1]	**1**

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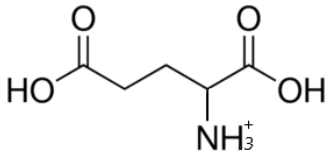
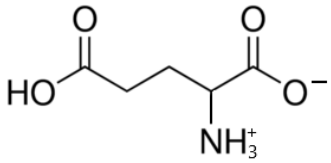
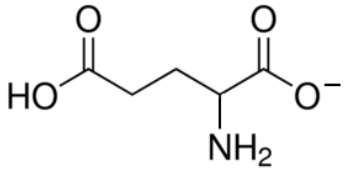
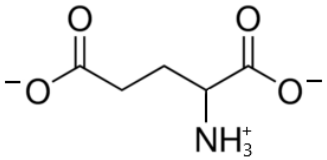
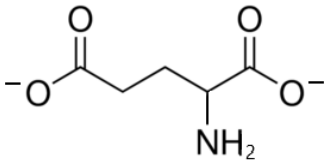
Question	Answer	Marks
8(h)	 at pH 1 [1]  at pH 3 **AND**   or at pH 9 [1]  at pH 14 [1]	**3**