Cambridge Assessment International Education

Cambridge International AS & A Level

CHEMISTRY **9701/23**

Paper 2 AS Level Structured Questions **May/June 2023**

MARK SCHEME

Maximum Mark: 60

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 May/June 2023 series for most Cambridge IGCSE, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

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 descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

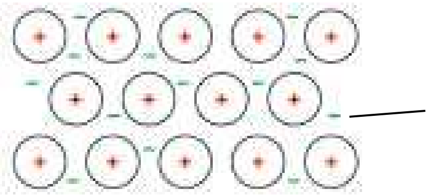
GENERIC MARKING PRINCIPLE 1: Marks must be awarded in line with: • the specific content of the mark scheme or the generic level descriptors for the question • the specific skills defined in the mark scheme or in the generic level descriptors for the question • the standard of response required by a candidate 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.

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	<u>'List rule' guidance</u> 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.

6	<u>Calculation specific guidance</u> 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	<u>Guidance for chemical equations</u> 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.

Question	Answer	Marks
1(a)(i)	giant metallic	**1**
1(a)(ii)	 delocalised electrons **M1** diagram showing minimum of 4 particles • circles containing just a + do not have to be labelled • empty circles / circles with Cu must be labelled + ion / positive ion / cation / Cu^{n+} **AND** with the circles surrounded by electrons shown as e^- / – **OR** little circles labelled delocalised electrons	**1**
1(b)(i)	(the mass of) one twelfth of the mass of a C-12 / ^{12}C atom (or isotope)	**1**
1(b)(ii)	average mass of the isotopes of an element compared to the unified atomic mass unit	**1**
1(b)(iii)	$(62.93 \times 69.15) \div 100 + (64.928 \times 30.85) \div 100 = 63.55 / 63.546$	**1**
1(c)	$^{63}Cu^{2+}$	**1**
1(d)(i)	$2Cu^{2+} + 4I^{-} \rightarrow 2CuI + I_2$	**1**
1(d)(ii)	Cu^{2+} OR $CuSO_4$ **AND** copper (species / ion) has gained / taken electron(s) from iodide (ion)	**1**
1(d)(iii)	$1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^9(4s^0)$	**1**

Question	Answer	Marks
2(a)(i)	it / aluminium oxide is insoluble (in water) **OR** it / aluminium oxide does not react (with water)	**1**
2(a)(ii)	**M1** correct state of correct aluminium product **M2** balanced equation for reaction of aluminium oxide with NaOH $Al_2O_3 + 2NaOH + 3H_2O \rightarrow 2NaAl(OH)_4(aq)$ **OR** $Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2(aq) + H_2O$	**2**
2(a)(iii)	sodium (only)	**1**
2(b)	$Mg(NO_3)_2$	**1**
2(c)(i)	Al (+)3 / III **AND** P (+)5 / V	**1**
2(c)(ii)	different number of valence/outer shell electrons	**1**
2(c)(iii)	$PCl_5 + 4H_2O \rightarrow H_3PO_4 + 5HCl$	**1**
2(c)(iv)	hydrolysis / substitution	**1**
2(c)(v)	HCl(g) dissolves in water to make (hydrochloric) acid	**1**

Question	Answer	Marks
3(a)	**M1** (energy change) when 1 mole of water is formed **M2** from an (aqueous) acid and an alkali / aqueous base	**2**
3(b)(i)	0.05 mol (H_2SO_4(aq))	**1**
3(b)(ii)	**M1** *correct value for Q (using 0.1 mol H_2O /* ***OR*** *2× (b)(i)) (and Q in Joules)* **M2** *calculate ΔT (using* their *Q* **AND** 110*)* Q/mc=ΔT = (Q) ÷ (4.18 × 110) = 12.42 (°C) **M3** use ΔT and initial temperature to find temperature of final solution 21.4 + M2 = 33.8 (°C) [M3 ΔT + 21.4 = T_{max}]	**3**
3(c)(i)	$CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$	**1**
3(c)(ii)	(additional) energy is involved / required to fully ionise / dissociate (weak / ethanoic acid) **OR** (additional) energy is involved / required to donate/ release H^+ ions	**1**

Question	Answer	Marks
4(a)(i)	$2KCl + H_2SO_4 \rightarrow K_2SO_4 + 2HCl$ **OR** $KCl + H_2SO_4 \rightarrow KHSO_4 + HCl$	**1**

Question	Answer	Marks
4(a)(ii)	**M1** HI(g) is not the only gaseous product **OR** SO_2 and / or H_2S and / or $I_2(g)$ is (also) made **M2** HI / iodide (ion) is oxidised **OR** H_2SO_4 oxidises HI **OR** HI reduces sulfuric acid	**2**
4(b)(i)	(from colourless) to purple	**1**
4(b)(ii)	$K_C = [H_2][I_2] / [HI]^2$ **OR** $0.0217 = [H_2][I_2] / [HI]^2$	**1**
4(b)(iii)	**M1** [HI] at equilibrium = 1.7 / 2 = 0.85 **M2** idea that $[H_2] = [I_2]$ in equilibrium mixture **M3** correct calculation based on correct rearrangement of equation in (b)(ii), 0.0217 and their M1 = 0.125	**3**
4(c)(i)	new mixture will have a lower / smaller conc / amount of H_2 and I_2	**1**
4(c)(ii)	endothermic **AND** decrease in temperature causes position of equilibrium to shift in exothermic direction	**1**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>5(a)</td><td>C_3H_7O</td><td>1</td></tr>
<tr><td>5(b)(i)</td><td>$C_6H_{10}O_3 + [6H] \rightarrow C_6H_{14}O_2 + H_2O$</td><td>1</td></tr>
<tr><td>5(b)(ii)</td><td>$LiAlH_4$ (in dry ether)</td><td>1</td></tr>
<tr><td>5(c)</td><td>
<table>
<tr><td>type of hybridisation</td><td>sp^2</td><td>sp^3</td></tr>
<tr><td>number of carbon atoms in X</td><td>2</td><td>4</td></tr>
</table>
</td><td>2</td></tr>
<tr><td>5(d)</td><td>
<table>
<tr><td>reagent</td><td>observation on addition to X</td><td>observation on addition to Y</td></tr>
<tr><td>sodium carbonate solution</td><td>effervescence</td><td>no change</td></tr>
<tr><td>2,4-DNPH</td><td>orange precipitate</td><td>no change</td></tr>
<tr><td>alkaline aqueous iodine</td><td>yellow precipitate</td><td>yellow precipitate</td></tr>
</table>

Two correct for one mark, four correct for two marks, six correct for three marks</td><td>3</td></tr>
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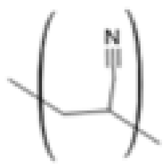
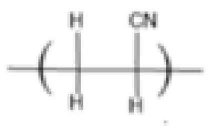
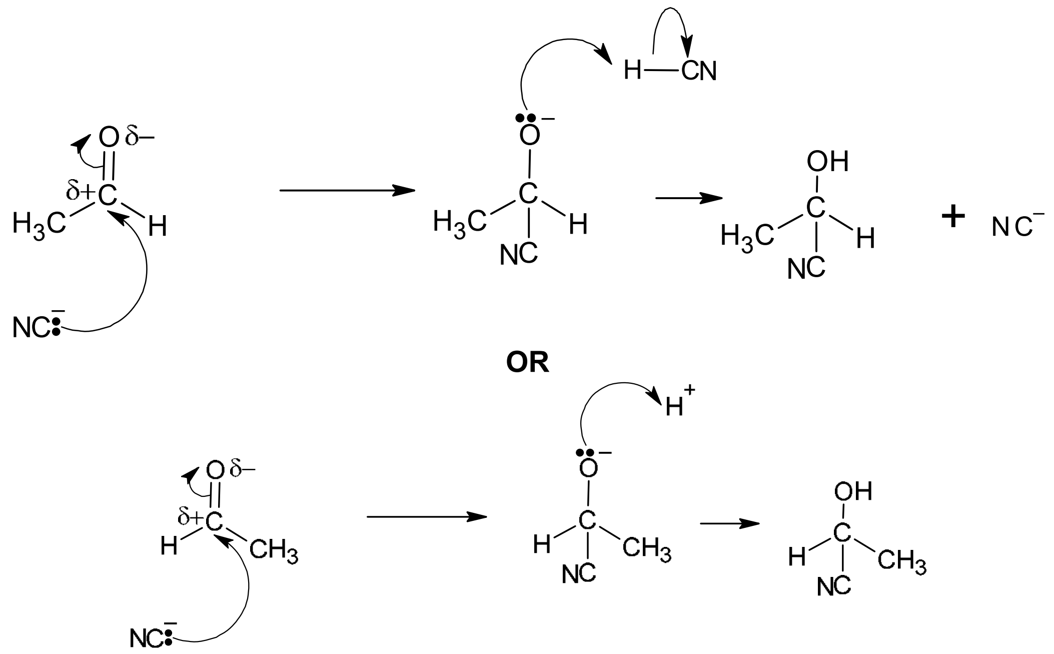
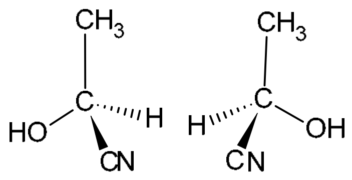
<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>6(a)</td><td> OR </td><td>1</td></tr>
<tr><td>6(b)(i)</td><td>nucleophilic addition</td><td>1</td></tr>
</table>

Question	Answer	Marks
6(b)(ii)	 **M1** correct dipole on C=O **AND** curly arrow from C=O bond to O **AND** from lone pair of electrons on C of :CN^- **M2** correct intermediate (charge on O or overall) **M3** curly arrow from lone pair of electrons on O to H^+ **AND** correct organic product (+ CN^-)	3
6(b)(iii)	heat + conc. sulfuric acid / conc. phosphoric acid **OR** heat + Al_2O_3	1
6(b)(iv)	**S** C≡N **AND** **T** C=C	1
6(c)(i)	(molecules / compounds with the) same structural formula (and same molecular formula) with different arrangement of atoms / groups in space	1
6(c)(ii)	**M1** restricted rotation of C=C (bond) **M2** each C of the double bond has two different groups / two different atoms (attached)	2

Question	Answer	Marks
6(d)	 A pair of molecules of 2-hydroxypropanenitrile with bonds represented in 3-d **AND** the pair of molecules are non-superimposable images	**1**
6(e)	$CH_3CH_2CN + 2H_2 \rightarrow CH_3CH_2CH_2NH_2$	**1**
6(f)(i)	substitution	**1**
6(f)(ii)	**M1** ammonia / NH_3 **M2** heat + (M1 in ethanol) under pressure	**2**