CAMBRIDGE
International Education

Cambridge International AS & A Level

CHEMISTRY **9701/22**

Paper 2 AS Level Structured Questions **May/June 2024**

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 2024 series for most Cambridge IGCSE, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

© Cambridge University Press & Assessment 2024

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.

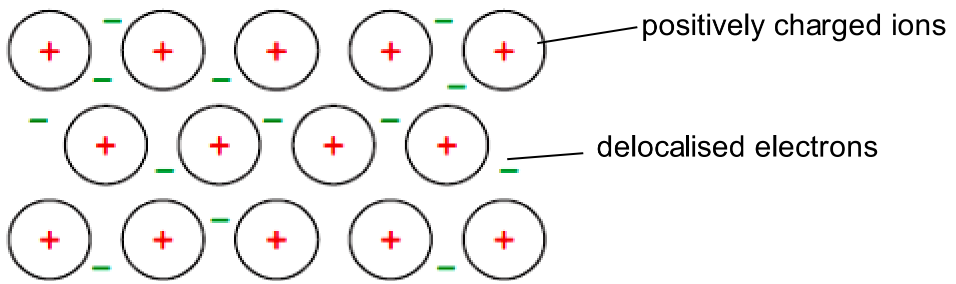
GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely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

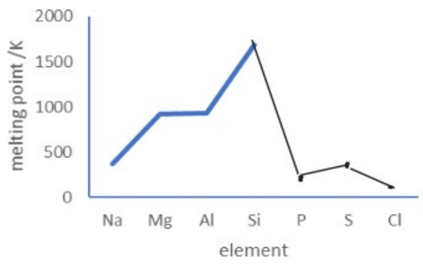
© Cambridge University Press & Assessment 2024

Science-Specific Marking Principles

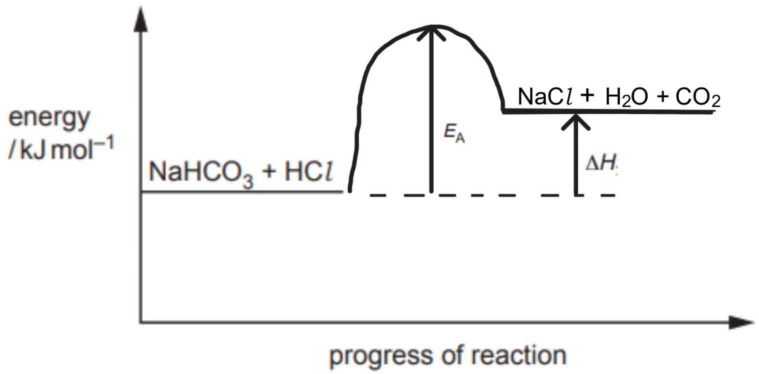
1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit 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	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.

Question	Answer	Marks
1(a)	Mg^{2+} | 24 | 12 | 10 Al^{3+} | 27 | 13 | 10 4 correct = 2 marks 2 or 3 correct = 1 mark 0 or 1 correct = 0 marks	2
1(b)	**M1** it / Al^{3+} is smaller (compared to Mg^{2+}) **M2** greater nuclear attraction for remaining electrons **M3** same shielding effect AND greater nuclear charge	3
1(c)	 labelled diagram shows: • regular arrangement of minimum of 2 × 2 circles containing + for positive ions • **AND** surrounded by (sea of) delocalised electrons	1
1(d)(i)	large amount of energy required to break bonds in giant covalent structure	1

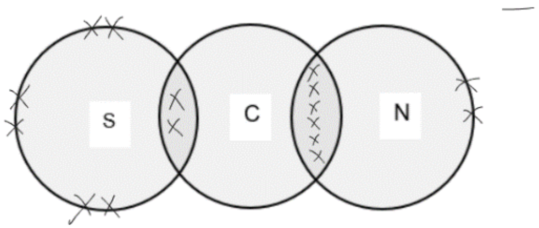
<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>1(d)(ii)</td><td>

M1 all 3 melting points lower than Mg
M2 show melting point Cl < P < S</td><td>2</td></tr>
<tr><td>1(e)(i)</td><td><table><tr><td>Na</td><td>solid</td><td>10–14</td></tr><tr><td>S</td><td>gas</td><td>0–4</td></tr></table>
4 correct = 2 marks
2 or 3 correct = 1 mark
0 or 1 correct = 0 marks</td><td>2</td></tr>
<tr><td>1(e)(ii)</td><td>acid–base OR neutralisation</td><td>1</td></tr>
<tr><td>1(e)(iii)</td><td>$P_4O_{10} + 6H_2O \rightarrow 4H_3PO_4$</td><td>1</td></tr>
<tr><td>1(f)(i)</td><td>reacts with both acids and bases OR shows both acidic and basic behaviour</td><td>1</td></tr>
<tr><td>1(f)(ii)</td><td>$Al(OH)_3 + NaOH \rightarrow NaAl(OH)_4$</td><td>1</td></tr>
</table>

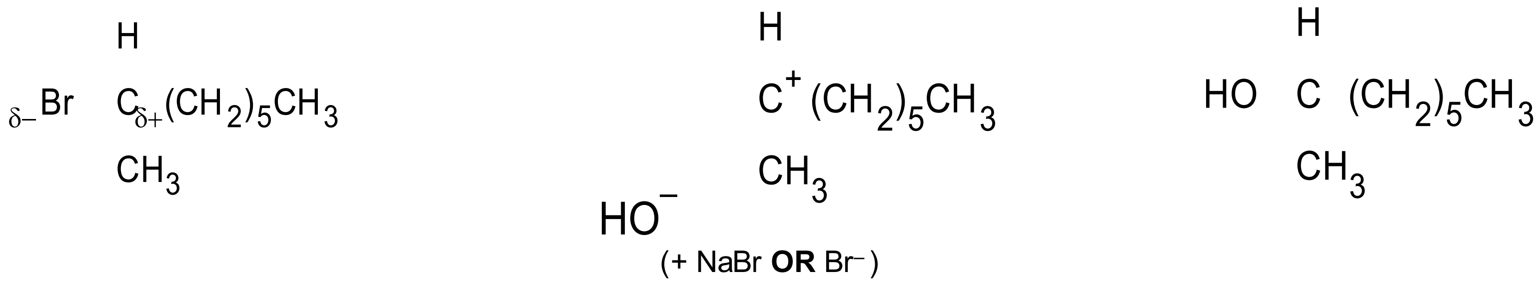
Question	Answer	Marks
2(a)	 *All three correct (2 marks) or two correct (1 mark):* • profile for endothermic reaction (include 'hump') • arrow representing E_A • arrow representing ΔH **OR** (+) 27.2	**2**
2(b)(i)	no more fizzing / effervescence stops	**1**
2(b)(ii)	**M1** calculate Q from = 50 × 4.18 × (26.2 – 19.6)) = 1379.(4) **M2** *Use M1 to find energy change when 1 mol Na_2CO_3 / 2 mol HCl reacts* **M1** ÷ 0.04 = 34485 **M3** *express Q as $\Delta H_{(1)}$ in kJ mol^{-1}* = – (value for **M2**) ÷ 1000 = –34.5 kJ mol^{-1} *Alternative method* **M1** *evidence of use* $Q = mc\Delta T$ = 50 × 4.18 / 1000 × (26.2 – 19.6) = 1.3794 **M2** *Use M1 to find energy change when 1 mol Na_2CO_3 / 2 mol HCl reacts* **M1** ÷ 0.04 = 34.485 **M3** *express Q as $\Delta H_{(1)}$ in kJ mol^{-1}* = – (value for **M2**) *(expressed in kJ)* = –34.5 kJ mol^{-1}	**3**

Question	Answer	Marks
2(b)(iii)	*Using answer from 2(b)(ii)* (=) $2\Delta H_2 - (\Delta H_1)$ (=) 2 × 27.2 – (2b(ii)) 2 × 27.2 – (–34.50) = (+) 88.9 kJ mol^{-1} *All three correct (2 marks) or two correct (1 mark):* • (27.2) – (–34.5) OR (27.2) – (2b(ii)) • 2 × 27.2 and 1 × 2b(ii) • calculate correctly their expression Using **alternative** value of ΔH_1 = –38.4 kJ mol^{-1} ΔH_r = (+)92.8 kJ mol^{-1} = 2 marks	**2**
2(c)	$Ca(NO_3)_2 \rightarrow CaO + 2NO_2 + ½O_2$ **M1** correct formula for calcium nitrate: $Ca(NO_3)_2$ **M2** correct balanced equation	**2**

Question	Answer	Marks
3(a)	**M1** rates of forward and reverse / backward reactions are equal **M2** no change in measurable properties **OR** concentration of reactants **AND** products remain constant	**2**
3(b)(i)	**M1** change to appearance of the mixture: (goes) darker red / more red **M2** change to relative concentration of Fe^{3+}(aq): decreases **M3** change to the value of equilibrium constant, K_c: constant / none	**3**

Question	Answer	Marks
3(b)(ii)	Method 1 **M1** conc of initial conc of Fe^{3+} and SCN^{-} = 0.0020 ($mol\,dm^{-3}$) **M2** at equilibrium the conc of Fe^{3+} and SCN^{-} are (M1 – 0.000423) **M3** use $0.000423 \div (\mathbf{M1} - 0.000423)^2$ to calculate K_c = 170(.089) **M4** units = $mol^{-1}\,dm^3$ **OR** $dm^3\,mol^{-1}$ Method 2 **M1** no mol $FeSCN^{2+}$ = $4.23 \times 10^{-4} \times 25 / 1000 = 1.0575 \times 10^{-5}$ **M2** no mol Fe^{3+} and SCN^{-} are (5×10^{-5} – **M1**) = 3.9425×10^{-5} **M3** $0.000423 \div (\mathbf{M2} \times 1000 / 25)^2$ = 170(.089) **M4** units = $mol^{-1}\,dm^3$ **OR** $dm^3\,mol^{-1}$	4
3(c)	*full electronic configuration of Fe^{3+}* $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^5$	1
3(d)	 **M1** 6 electrons between C and N **AND** 2 electrons between C and S **M2** 3 lone pairs around S **AND** none around C **AND** 1 lone pair around N	2

Question	Answer	Marks
4(a)	Three-dimensional stereoisomers of $CH_3(CH_2)_5CHBrCH_3$  **M1** correct representation of left-hand answer as 3d structure of one of the enantiomers of $CH_3(CH_2)_5CHBrCH_3$ **M2** correct representation of 3d structure of the second enantiomer of $CH_3(CH_2)_5CHBrCH_3$	2

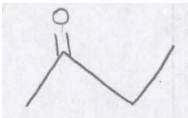
Question	Answer	Marks
4(b)	 **M1** correct dipole ($^{\delta+}$C—Br$^{\delta-}$) **AND** curly arrow from bond of C—Br to Br (or just beyond) **M2** correct intermediate **ALLOW** R for $–(CH_2)_5CH_3$ **M3** curly arrow from lone pair on OH^- to the C of intermediate (or suitable position where C–OH bond is made) *If SN2 mechanism shown:* Apply SN2 mechanism mark scheme **only** if mechanism shows OH / NaOH species attacking the reactant and no OH **M1** correct dipole ($^{\delta+}$C—Br$^{\delta-}$) AND curly arrow from bond of C—Br to Br of reactant (or just beyond) **NOT M2** **M3** curly arrow from lone pair on $:OH^-$ to the appropriate C of the reactant	**3**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>4(c)</td><td>
<table>
<tr><td>Chemical test</td><td>observation with 2-bromooctane</td><td>observation with octan-2-ol</td><td>observation with $CH_3(CH_2)_5CHCH_2$</td></tr>
<tr><td>Br_2 in the dark</td><td>×</td><td></td><td>orange / brown to colourless</td></tr>
<tr><td>PCl_5</td><td></td><td>steamy fumes</td><td>×</td></tr>
<tr><td>$AgNO_3(aq)$</td><td>cream precipitate
OR
off white precipitate</td><td>×</td><td></td></tr>
</table>

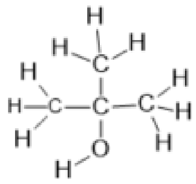
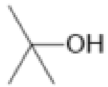
6 correct answers = 3 marks
4 or 5 correct answers = 2 marks
2 or 3 correct answers = 1 mark
0 or 1 correct answer = 0 marks</td><td>3</td></tr>
<tr><td>4(d)(i)</td><td>elimination</td><td>1</td></tr>
<tr><td>4(d)(ii)</td><td>NaOH / sodium hydroxide in ethanol</td><td>1</td></tr>
<tr><td>4(e)(i)</td><td>
<table>
<tr><td></td><td>0</td><td>2</td><td>6</td></tr>
</table>

3 correct answers = 2 marks
2 correct answers = 1 mark
0 or 1 correct answers = 0 marks</td><td>2</td></tr>
</table>

Question	Answer	Marks
4(e)(ii)	**M1** presence of a π bond **M2** limited rotation of C=C bond **M3 EITHER** two different groups on each / both double bonded carbon atoms **OR** two different atoms on each / both double bonded carbon atom **OR** one H / atom and one alkyl group on each / both double bonded carbon atom	3

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>5(a)(i)</td><td>$4 = \dfrac{100 \times x}{1.1 \times 50} = 2.2$</td><td>1</td></tr>
<tr><td>5(a)(ii)</td><td>M1 m / e = 29 $C_2H_5^+$
M2 m / e = 59 $C_3H_7O^+$</td><td>2</td></tr>
<tr><td>5(b)(i)</td><td><table>
<tr><td>absorption</td><td>bond</td><td>functional group containing the bond</td></tr>
<tr><td>A</td><td>O–H</td><td>hydroxy(l) / alcohol</td></tr>
<tr><td>B</td><td>C=O</td><td>carbonyl</td></tr>
</table></td><td>1</td></tr>
<tr><td>5(b)(ii)</td><td>$CH_3CH_2CO(CH_3)$ OR </td><td>1</td></tr>
<tr><td>5(c)(i)</td><td>hydroxyl</td><td>1</td></tr>
<tr><td>5(c)(ii)</td><td>(1)$C_4H_{10}O$ + (1)Na → $C_4H_9ONa + ½H_2$</td><td>1</td></tr>
</table>

© Cambridge University Press & Assessment 2024

Question	Answer	Marks
5(c)(iii)	 **OR** 	**1**

© Cambridge University Press & Assessment 2024