Cambridge Assessment International Education

Cambridge International AS & A Level

CHEMISTRY **9701/23**

Paper 2 AS Level Structured Questions **May/June 2022**

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 2022 series for most Cambridge IGCSE, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

© UCLES 2022

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.

© UCLES 2022

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.

© UCLES 2022

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.

© UCLES 2022

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.

© UCLES 2022

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>1(a)</td><td>• energy required
• when one electron is removed
• from each atom in one mole of
• gaseous atoms
two or three points for one mark, four points for two marks</td><td>2</td></tr>
<tr><td>1(b)</td><td>Group VI / 16 AND large increase (in IE) after 6th</td><td>1</td></tr>
<tr><td>1(c)</td><td>M1 reference to spin pair repulsion in (3)p orbital (in S)
OR due to repulsion of two electrons in a (3)p orbital (in S)

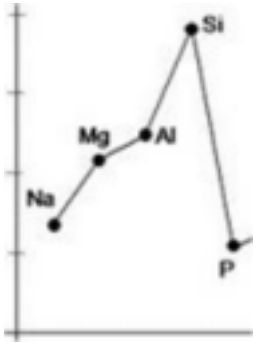
M2 outweighs increased nuclear charge (in S)</td><td>2</td></tr>
<tr><td>1(d)</td><td>M1 similarity in electronic structure / shielding of Al^{2+} and Na
both remove electron from (3)s^1 / single electron in (3)s (sub-level / orbital)
OR Al^{2+} and Na have same electronic configuration
OR shielding (of outer electron) is the same

M2 greater nuclear charge / number of protons
$Al^{(2+)}$ has greater nuclear charge
OR 13p compared to 11p</td><td>2</td></tr>
<tr><td>1(e)</td><td><table><tr><th></th><th>atomic no.</th><th>nucleon no.</th><th>no.of neutrons</th><th>electronic arrangement</th></tr><tr><td>copper –65</td><td>29</td><td>65</td><td>65 – 29 = 36</td><td>$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}4s^1$</td></tr></table>
M1 29 AND 65

M2 nucleon no – atomic no
ALLOW ecf from M1

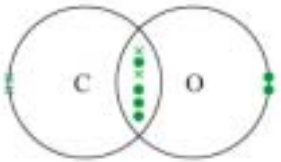
M3 electronic arrangement</td><td>3</td></tr>
</table>

Question	Answer	Marks
1(f)(i)	M_r = 63.5 (1.05 / 63.5) × 6.022 × 10^{23} = 9.95**8** × 10^{21} **OR** 9.96 × 10^{21}	**1**
1(f)(ii)	**M1** *comment explaining high melting point of Cu* many strong metallic bonds **OR** many strong (electrostatic) attractions between cations and delocalised electrons **OR** strong bonds in giant metallic structure. **M2** *comment explaining electrical conductivity of Cu* delocalised electrons are free are to move through the structure (owtte)	**2**

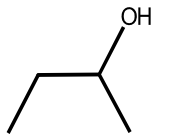
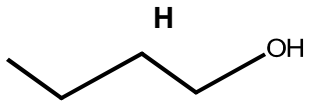
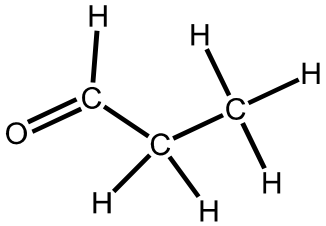
Question	Answer	Marks
2(a)(i)		**3**

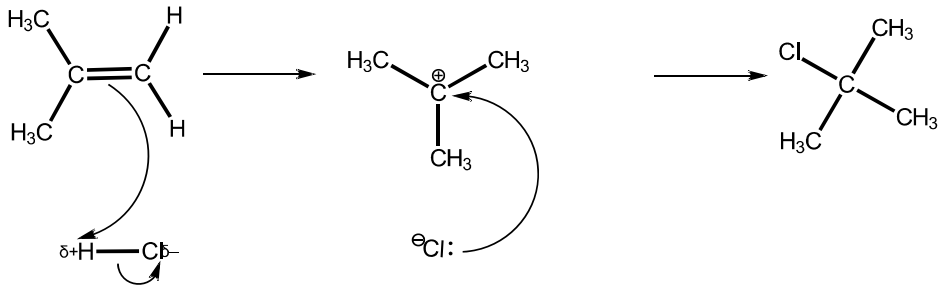
<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(a)(ii)</td><td>
<table>
<tr><td></td><td>sodium chloride</td><td>phosphorus (V) chloride</td></tr>
<tr><td>state at room temperature</td><td>solid</td><td>solid</td></tr>
<tr><td>name of change which occurs on addition of water</td><td>dissolves</td><td>hydrolysis</td></tr>
<tr><td>pH of final solution</td><td>7</td><td>1–2</td></tr>
</table>
</td><td>3</td></tr>
<tr><td>2(b)(i)</td><td>M1
$2NaTs + Br_2 \rightarrow 2NaBr + Ts_2$
OR $2Ts^- + Br_2 \rightarrow 2Br^- + Ts_2$

M2 Ts^- reduces Br / Br_2
OR reducing strength of halide (ion) increases down the group</td><td>2</td></tr>
<tr><td>2(b)(ii)</td><td>
<table>
<tr><td>element</td><td>chlorine</td><td>bromine</td><td>tennessine</td></tr>
<tr><td>melting point / °C</td><td>–101</td><td>–7.2</td><td>> 250</td></tr>
<tr><td>lattice structure of crystalline solid</td><td>simple molecular</td><td>simple molecular</td><td>giant metallic</td></tr>
</table>
</td><td>2</td></tr>
</table>

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>3(a)(i)</td><td>
</td><td>1</td></tr>
</table>

Question	Answer	Marks
3(a)(ii)	**M1** *expression OR value derived from using all bond energy values and ΔH correctly, ignoring stoichiometry* $-7 = (n350 + m360 + p410) - (q410 + r350 + sC{\equiv}O)$. **M2** *correct calculation based on correct expression AND stoichiometry* $[-7 = 2(350) + 2(360) + 10(410) - 10(410) - 350 - \times] = (+)1077\ kJ\ mol^{-1}$	**2**
3(a)(iii)	**M1** $K_c = \dfrac{[C2H6[CO][CH4]}{[C4H10O]}$ **M2** $mol^2\ dm^{-6}$	**2**
3(a)(iv)	**M1** no change / none **M2** I_2 is a catalyst **AND** does not affect position of equilibrium **OR** I_2 is a catalyst **AND** reduces time taken to reach (same) equilibrium	**2**
3(a)(v)	• start at origin and not crossing original until beyond the peak • peak to the right-hand side of original peak **AND** lower than original • line does not cross the original after the peak reached	**2**
3(b)(i)	functional group	**1**
3(b)(ii)	positional	**1**

Question	Answer	Marks
3(b)(iii)	**J**  name: butan-2-ol **H**  name: butan-1-ol **M1** correct structures **M2** correct structures in correct boxes **H** and **J** **M3** correct corresponding name of both **H** and **J**	**3**
3(c)	**displayed** formula of propanal  **M1** identification of propanal **M2** correct use of displayed formula and correct formula used	**2**

Question	Answer	Marks
4(a)(i)	 **M1** curly arrow from = to H AND correct dipole on H–C*l* **M2** correct intermediate **M3** curly arrow from H–C*l* bond to C*l* **AND** curly arrow from lp on: C*l*$^-$ to C$^+$	**3**
4(a)(ii)	• intermediate **OR** C+ **OR** carbocation (formed) is more stable • due to greater (positive) inductive effect. • caused by 3 methyl groups / 3 alkyl groups / more alkyl groups attached to C$^+$ / central C	**2**
4(b)(i)	**M1** hydroxy(l) **M2** substitution	**2**
4(b)(ii)	$I^- + Ag^+ \rightarrow AgI$	**1**
4(b)(iii)	**M** **AND** C–I (bond) is weak(er)	**1**
4(b)(iv)	$C_2H_5COO^-$ **OR** $CH_3CH_2CO_2^-$ or propanoate (an)ion	**1**
4(b)(v)	$CH_3CH_2CHICH_3$ **M1** correct identification of I on 4C molecule **M2** unambiguous structure of **M** – unbranched with 4C and I on 2C	**2**

Question	Answer	Marks
5(a)(i)	cold + dilute	**1**
5(a)(ii)	**M1** unbranched 4C structure **AND** any number of –OH in any position **M2** 0.001 mol H_2 made from 0.001 mol **Y** **AND** R–OH + Na $\rightarrow$ RONa + ½H_2 **OR** use of 1 OH (group) $\rightarrow$ ½H_2 **M3** $CH_3CH(OH)CH(OH)CH_3$	**3**
5(b)(i)	100 $\times$ 2.2 / 1.1 $\times$ 100 = 2	**1**
5(b)(ii)	chlorine / C*l* **AND** peak at M+2 represents the molecular ion with 37–C*l* (rather than 35–C*l* as relative abundance of (peaks) M: M+2 is 100:33 / 3:1) **OR** relative abundance of (peaks) M: M+2 is 100:33.3 / 3:1 (so peak at M+2 contains 37–C*l*)	**1**
5(b)(iii)	m / e = 29: $C_2H_5^+$ m / e = 49: CH_2Cl^+ name of Z: chloroethane	**3**