Cambridge Assessment International Education

Cambridge International AS & A Level

CHEMISTRY **9701/22**

Paper 2 AS Structured Questions **October/November 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 October/November 2022 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 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.

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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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Examples of how to apply the list rule
State **three** reasons…. [3]

A

1	Correct	✓	**2**
2	Correct	✓	
3	Wrong	×	

B (4 responses)

1	Correct, Correct	✓, ✓	**3**
2	Correct	✓	
3	Wrong	ignore	

C (4 responses)

1	Correct	✓	**2**
2	Correct, Wrong	✓, ×	
3	Correct	ignore	

D (4 responses)

1	Correct	✓	**2**
2	Correct, CON (of 2.)	×, (discount 2)	
3	Correct	✓	

E (4 responses)

1	Correct	✓	**3**
2	Correct	✓	
3	Correct, Wrong	✓	

F (4 responses)

1	Correct	✓	**2**
2	Correct	✓	
3	Correct CON (of 3.)	× (discount 3)	

G (5 responses)

1	Correct	✓	**3**
2	Correct	✓	
3	Correct Correct CON (of 4.)	✓ ignore ignore	

H (4 responses)

1	Correct	✓	**2**
2	Correct	×	
3	CON (of 2.) Correct	(discount 2) ✓	

I (4 responses)

1	Correct	✓	**2**
2	Correct	×	
3	Correct CON (of 2.)	✓ (discount 2)	

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Abbreviations on mark scheme
owtte = or words to that effect. It applies throughout the mark scheme **but added occasionally as a reminder.**
ora = or reverse argument
TE = transcription error
AE = arithmetic error

If an entire answer is shown within the answer space (& no other indication from candidate) treat work outside the space as working and **IGNORE** working.

Marking crossed out work If all the answer has been crossed out but **not** replaced and is legible then it should be marked. If all the answer has been crossed and replaced with another answer, **IGNORE** the crossed-out material.

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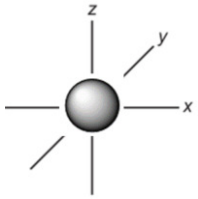
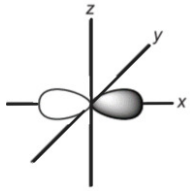
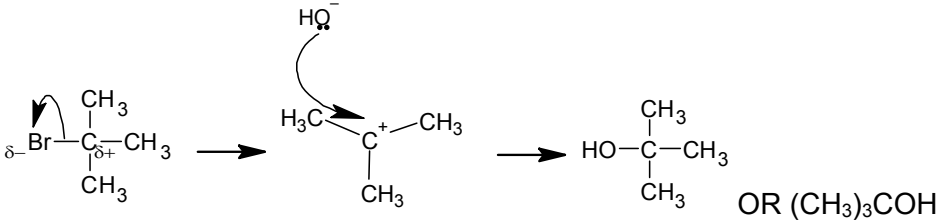
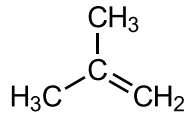
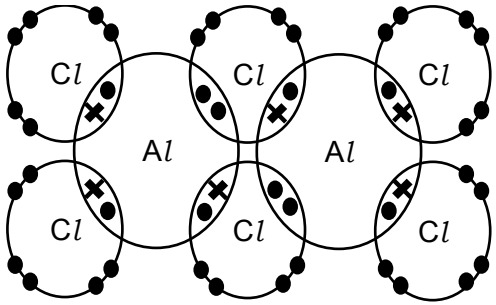
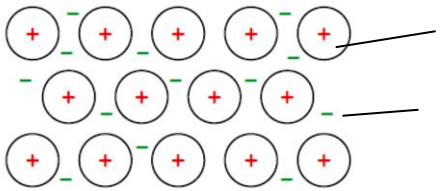
Question	Answer	Marks
1(a)	**M1** ionic = oppositely charged ions / cations **AND** anions	**1**
	M2 covalent = shared pair(s) of electrons **AND** two nuclei	**1**
1(b)	NH_4^+ 11 p^+ **AND** 10 e^-	**1**
	CO_3^{2-} 30 p^+ **AND** 32 e^-	**1**
	PO_4^{3-} 47 p^+ **AND** 50 e^-	**1**
1(c)(i)	proton / H^+ donor	**1**
1(c)(ii)	***ionic** equation* $NH_4^+ + OH^- \rightarrow NH_3 + H_2O$	**1**
1(c)(iii)	 2s  $2p_x$	**2**
1(d)(i)	phosphate(V)	**1**
1(d)(ii)	*(molecular mass of NH_4MgPO_4)* = 137.3	**1**
	(245.3 – $M_r(NH_4MgPO_4)$ ÷ 18.0) = 6	**1**

Question	Answer	Marks
1(e)(i)	 OR $(CH_3)_3COH$ **M1** correct dipole in on $^{\delta+}C—Br^{\delta-}$ (in $^{t}BuBr$) **AND** curly arrow from C—Br to Br	**1**
	M2 curly arrow from electron pair on O of $^{-}$:OH / :OH^{-} to C^{+} in carbocation	**1**
	M3 $^{t}BuOH$ product	**1**
1(e)(ii)	The C—Br carbon is bonded to three other carbon atoms *owtte*	**1**
1(e)(iii)		**1**

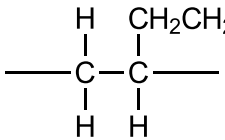
Question	Answer	Marks
2(a)	<table><tr><td>NaC*l*</td><td>A*l*C*l*$_3$</td><td>SiC*l*$_4$</td><td>PC*l*$_5$</td></tr><tr><td>I</td><td>I OR C</td><td>C</td><td>C</td></tr></table>	**1**
	<table><tr><td>G</td><td>G</td><td>S</td><td>S</td></tr></table>	**1**
	<table><tr><td>+1</td><td>+3</td><td>+4</td><td>+5</td></tr></table>	**1**
	<table><tr><td>+3</td><td>+2</td></tr></table>	**1**
2(b)	**M1** NaC*l*(s) → Na$^+$(aq) + C*l*$^-$(aq)	**1**
	PC*l*$_5$(s) + 4H$_2$O(l) → H$_3$PO$_4$(aq) + 5HC*l*(aq) **M2** balanced equation	**1**
	M3 all state symbols for PC*l*$_5$ equation	**1**
2(c)(i)		**1**
	'dot-and-cross' diagram to show **M1** correct number and connectivity of C*l* and A*l* atoms **M2** 2 correct dative bonds (••) between C*l* and A*l* of A*l*C*l*$_3$ neighbour **AND** correct number of non-bonding electrons around each atom of A*l*$_2$C*l*$_6$	**1**

Question	Answer	Marks
2(c)(ii)	reaction is exothermic so equilibrium shifts to the LHS OR equilibrium shifts to LHS because forward reaction is exothermic OR equilibrium shifts to LHS because backward reaction is endothermic OR endothermic reaction is favoured so more reactants / are $AlCl_3$ is made	**1**
2(d)	**M1** *value of n based on re-arranged equation for 'n' and substitution of correct values* $n = \frac{3.23 \times 10^5 \bullet 250 \times 10^{-6}}{8.31 \bullet 500} = 0.0194(34416)$	**1**
	M2 calculated value of M_r based on M1 $M_r = 3.30 \div n = 170$	**1**
	M3 period 3 chloride which matches M_r in M2 (formula) $SiCl_4$	**1**
2(e)(i)	**M1** orange colour (of solution) remains / no visible reaction	**1**
	M2 bromine/Br_2 cannot oxidise chloride/Cl^- OR bromine/Br_2 is not a strong enough oxidising agent (to oxidise chloride/Cl^-)	**1**

Question	Answer	Marks
2(e)(ii)	**M1** sum of instantaneous dipole – dipole attractions and permanent dipole attractions in SCl_2 is greater than those in SBr_2 OR permanent dipole-permanent dipole (forces) in SCl_2 are stronger OR intermolecular forces are stronger in SCl_2 ***ora***	**1**
	M2 SCl_2 (molecule / bond) is more polar than SBr_2 OR Cl is more electronegative than Br so SCl_2 has stronger (permanent) dipoles ***ora***	**1**
2(f)(i)	 **M1** diagram showing minimum of 4 particles (in total in 2 rows) • circles containing Bi^{n+} do not have to be labelled •  must be labelled as 'ion' OR empty circles / circles with Bi must be labelled + ion / positive ion / cation / Bi^{n+} AND • with the circles surrounded by electrons shown as e^- / – OR little circles labelled electrons	**1**
	M2 label / legend showing <u>delocalised</u> electrons	**1**
2(f)(ii)	**M1** (structure =) simple/molecular, because it has a low melting/boiling point *owtte*	**1**
	M2 (bonding =) covalent, because it is hydrolysed	**1**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td rowspan="4">3(a)(i)</td><td><table><tr><td>M1
Tollens’ OR Fehling’s OR $K_2Cr_2O_7$ OR $KMnO_4$

OR alkaline I_2(aq) with</td><td><u>M2</u>
<u>A1</u> gives silver mirror OR brick-red ppt OR (orange solution) turns green OR (purple solution) turns colourless

<u>A2</u> gives yellow ppt</td></tr></table></td><td>2</td></tr>
<tr><td><table><tr><td>M3 alkaline I_2(aq)</td><td>M4 <u>B1</u> gives yellow ppt</td></tr></table></td><td>2</td></tr>
<tr><td><table><tr><td>M5 2,4-DNPH</td><td>M6
<u>C1</u> gives red/orange/yellow ppt</td></tr></table></td><td>2</td></tr>
<tr><td><table><tr><td>M7 Br_2(aq)</td><td>M8
<u>D2</u> turns it (orange to) colourless</td></tr></table></td><td>2</td></tr>
<tr><td>3(a)(ii)</td><td>molecules with the same molecular formula
AND
different structural formulae owtte</td><td>1</td></tr>
<tr><td>3(a)(iii)</td><td>pentan-3-one</td><td>1</td></tr>
<tr><td>3(a)(iv)</td><td><u>molecular</u> formula
$C_5H_{10}O$</td><td>1</td></tr>
<tr><td>3(b)(i)</td><td>addition</td><td>1</td></tr>
<tr><td rowspan="2">3(b)(ii)</td><td>
M1 correct carbon backbone of one repeat unit including ‘dangling’ bonds</td><td>1</td></tr>
<tr><td>M2 rest of structure correct</td><td>1</td></tr>
</table>

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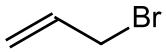
Question	Answer	Marks
3(c)(i)	C=C (bond) / alkene **AND** (absorption within) 1500–1680 cm^{-1} (present in **E**'s IR spectrum only)	**1**
3(c)(ii)	hydroxyl / alcohol **AND** (broad absorption within) 3200–3650 cm^{-1} (present in **F**'s IR spectrum only)	**1**
3(c)(iii)	120.9 / 121	**1**
3(c)(iv)		**1**
3(c)(v)	(1)H_2O + (1)[O] + $C_3H_5Br \rightarrow C_3H_7BrO_2$	**1**
3(d)	**M1** one portion of **A1**: $NaBH_4$ **AND** → propan-1-ol / $CH_3(CH_2)_2OH$	**1**
	M2 second portion of **A1**: acidified $K_2Cr_2O_7$ **AND** → propanoic acid / $C_2H_5CO_2H$	**1**
	M3 two products: conc(entrated mineral) acid / H^+ / H_2SO_4 (catalyst)	**1**