Cambridge Assessment International Education
Cambridge International Advanced Subsidiary and Advanced Level

CHEMISTRY **9701/22**

Paper 2 AS Level Structured Questions **February/March 2023**

MARK SCHEME

Maximum Mark : 60

Cambridge Assessment International Education – 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.

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 (see examples below)

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.

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)

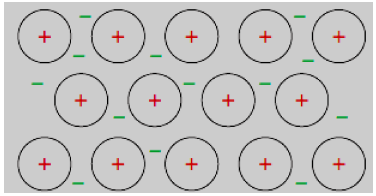
1. Correct	✔	**2**
2. Correct	☐	
3. CON (of 2.) Correct	(discount 2) ✔	

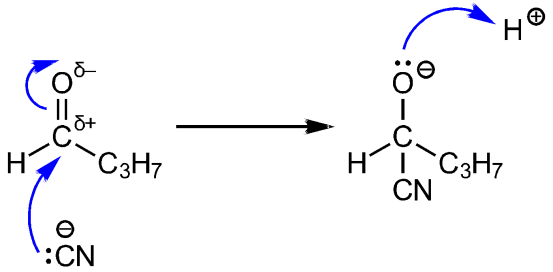
I (4 responses)

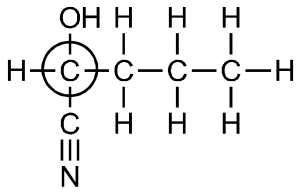
1. Correct	✔	**2**
2. Correct	☐	
3. Correct CON (of 2.)	✔ (discount 2)	

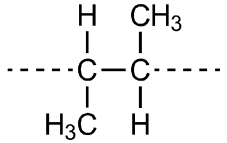
Question	Answer	Marks		Guidance
1 a i	power of an atom to attract electrons to itself	1	1	**ALLOW** …a bonding pair of electrons
1 a ii	● O lower nuclear charge / lower proton number ● O has one fewer shell than S / less shielding ● greater attraction for nucleus in O	2	2	●✔✔
1 b i		2	2	M1 electrons M2 charges
1 b ii	non-linear	1	1	**ALLOW** bent, V-shaped, arrow shaped, angular…
1 c i	$H(g) \rightarrow H^+(g) + e^-$	1	1	
1 c ii	H (cannot undergo second ionisation because it) only has one electron / H^+ has no electron	1	1	
1 c iii	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^2$	1	1	
1 d i	$SO_2 + H_2O \rightarrow H_2SO_3$	1	1	
1 d ii	$SO_2 + 2NaOH \rightarrow Na_2SO_3 + H_2O$	1	1	**ALLOW** $SO_2 + NaOH \rightarrow NaHSO_3$
1 d iii	$CO_2 + Mg(OH)_2 \rightarrow MgCO_3 + H_2O$	1	1	**ALLOW** $CO_2 + Mg(OH)_2 \rightarrow Mg(HCO_3)_2$
1 e i		2	2	●✔●✔

Question	Answer	Marks		Guidance
	<table><tr><td>compound</td><td>CO_2</td><td>O=S=O</td><td>S=C=S</td><td>S=C=O</td></tr><tr><td>overall dipole moment</td><td></td><td>✔</td><td></td><td>✔</td></tr></table>			
1 e ii	*conversion of units* 103000 Pa 127 × 10^{-6} m^3 423 K	1		
	Use of pV = (*m*/M_r)*RT* $M_r = \frac{0.284 \times 8.31 \times 423}{103000 \times 127 \times 10^{-6}}$	1	3	
	M_r = 76.3 **AND** compound = CS_2	1		**ALLOW** 76
		17	**17**	

Question	Answer	Marks		Guidance
2 a i		1		**ALLOW** 2+ cations **IGNORE** unequal number of +/– charges **ALLOW** e^- as label for electrons
	diagram shows regular arrangement of (positive) ions		2	MUST show regular arrangement for M1 (at least two rows)
	surrounded by/(sea of) delocalised electrons	1		**ALLOW** delocalised e^- on outside of structure
2 a ii	Mg has more delocalised e^- than Na	1	1	
2 b	$Mg + 2H_2O \rightarrow Mg(OH)_2 + H_2$	1	1	
2 c	reagent = any named/formula of soluble sulfate OR any named/formula of soluble hydroxide	1		Needs name or formula
	$BaSO_4$ insoluble & $MgSO_4$ soluble OR $Ba(OH)_2$ soluble & $Mg(OH)_2$ insoluble	1	2	**ALLOW** (white) ppt for insoluble salts and no ppt for soluble salts
2 d i	white precipitate dark grey solid / purple gas	2	2	Any two effervescence / misty fumes rotten egg smell Exothermic? Yellow solid?
2 d ii	moles of **X** = ½ (moles of $AgNO_3$) = ½ × $\frac{33.65}{1000}$ × 0.0500 = 8.41×10^{-4}	1		
	moles of **X** = 0.250 ÷ M_r(**X**) ∴ M_r(**X**) = 297.2	1	3	
	A_r of Group 2 element is 297.2 – 2(79.9) = 137.4 AND **X** is $BaBr_2$	1		**ALLOW** ECF X = RaBr if 1:2 ratio is missing?
		11	**11**	

Question	Answer	Marks		Guidance
3 a i	(a reaction where) two or more compounds/reagents/molecules form only one product	1	1	
3 a ii	position(al isomerism)	1	1	
3 a iii	butanal	1	1	**ALLOW** butyraldehyde
3 a iv	96% × (5000 / 42.0) × 72.0 = 8230 or 8229 (kg)	1	1	**ALLOW** 8200?
3 b i		1		
	curly arrow from lone pair on C of CN^- to $C^{\delta+}$		4	
	correct dipole on C=O **AND** curly arrow from C=O bond to $O^{\delta-}$	1		
	correct organic intermediate	1		
	curly arrow from lone pair on alkoxide O^- to H^+/H of HCN/H of H_2O (to reform the alcohol)	1		**IGNORE** curly arrow that breaks H—CN or H—OH (if either used instead of H^+)
3 b ii	acidified $K_2Cr_2O_7$	1		
	Tollens' reagent / ammoniacal $AgNO_3$ owtte	1	3	

Question	Answer	Marks		Guidance
	no reaction	1		**ALLOW** solution remains orange.
3 b iii	$C_4H_8O + [O] \rightarrow C_4H_8O_2$	1	1	
3 b iv		1	1	
3 c	*alkane* C_3H_8	1	2	
	alcohols $C_4H_{10}O$	1		
3 d I	increases the rate of reaction	1	2	
	by providing an alternative reaction pathway of lower E_a	1		
3 d ii	fewer moles of gas on right-hand side of equilibrium so equilibrium moves to right/products	1	1	
3 d iii	–187 –(–111) –(+52)	1	2	
	= –128 (kJ mol^{-1})	1		**ALLOW** ECF if only (–)187, (–)111, (+)52 used
3 d iv	instantaneous dipole—induced dipole / id—id / London / dispersion forces **AND** permanent dipole—permanent dipole / pd—pd / Keesom / orientation forces	1 1	2	**NOT** any mention of hydrogen bonding
		21	**21**	

Question	Answer	Marks		Guidance
4 a i	NaOH in alcohol/ethanol AND heat (under reflux)	1	1	**ALLOW** concentrated NaOH(aq) in alcohol **ALLOW** reflux for heat
4 a ii		1	1	**IGNORE** stereochemistry
4 a iii	$C_4H_{10}O/CH_3CH(OH)C_2H_5 \rightarrow C_4H_8/CH_3CHCHCH_3 + H_2O$	1	1	
4 b i	cream(-coloured)/off-white precipitate forms	1	1	
4 b ii	CHI_3 / iodoform / tr(i)iodomethane $CH_3CH_2CO_2^-$ / propanoate	1 1	2	Either order **ALLOW** sodium salt **NOT** carboxylic acid
4 c i	substitution	1	1	**ALLOW** reduction **IGNORE** nucleophilic/electrophilic/free-radical
4 c ii	reducing agent	1	1	
4 d i	**G** (absorption at) 2200–2250 cm^{-1} **AND** C≡N	1 1	2	
4 d ii	3.4 **AND** relative abundance of ^{79}Br:$^{81}Br \cong 50:50$ OR 1:1	1	1	
		11	**11**	