Cambridge International AS & A Level

Cambridge Assessment International Education
Cambridge International Advanced Subsidiary and Advanced Level

CHEMISTRY **9701/22**

Paper 2 AS Level Structured Questions **March 2019**

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 March 2019 series for most Cambridge IGCSE™, Cambridge International A and AS Level 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**:

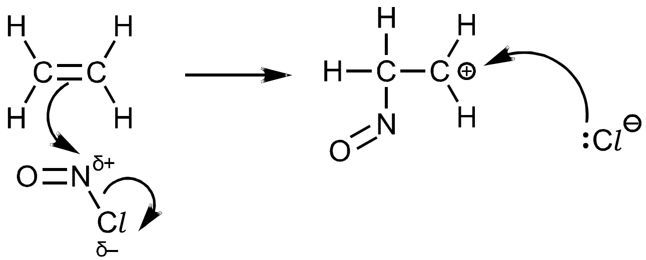
- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can 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:

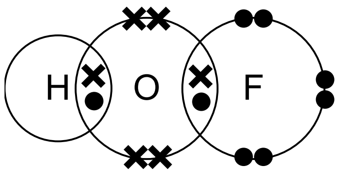
Rules must be applied consistently e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

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.

Question	Answer	Marks
1(a)	strong triple bond / strong N≡N OR high activation energy / E_a OR non-polar	**1**
1(b)(i)	$3Mg + N_2 \rightarrow Mg_3N_2$	**1**
1(b)(ii)	solid disappears	**1**
1(c)(i)	(it is used to make) fertilisers	**1**
1(c)(ii)	**M1** CaO displaces NH_3 (from its salt / NH_4^+) **M2** CaO is a stronger base / more basic (than NH_3)	**2**
1(d)(i)	NO: (+)2 / (+)II NO_2: (+)4 / (+)IV	**1**
1(d)(ii)	**M1** $\frac{1}{2}N_2 + O_2 \rightarrow NO_2$ **M2** $Mg(NO_3)_2 \rightarrow MgO + 2NO_2 + \frac{1}{2}O_2$	**2**
1(d)(iii)	**M1** +82 (= $E_{O=O} - 2E_{N\rightarrow O}$) = (+)496 – 2 × $E_{N\rightarrow O}$ **M2** $E_{N\rightarrow O}$ = ½ × (496–82) = ½ × 414 = 207 (kJ mol^{-1})	**2**

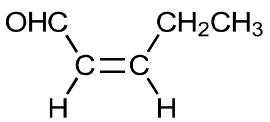
Question	Answer	Marks
1(e)	 **M1** curly arrow from C=C to $N^{\delta+}$ **AND** curly arrow from N—Cl to C$l^{\delta-}$ **M2** intermediate **AND** curly arrow from lone pair on Cl^- to C(+)	**2**

Question	Answer	Marks
2(a)(i)	**M1** ① mass of a molecule OR ② (weighted) average / mean mass of the molecules OR ③ mass of one mole of molecules **M2** ① / ② compared to $\frac{1}{12}$ (the mass) of an atom of carbon-12 OR on a scale in which a carbon-12 atom / isotope has a mass of (exactly) 12 (units) ③ relative / compared to $\frac{1}{12}$ (the mass) of 1 mole of carbon-12 OR on a scale in which 1 mole of carbon-12 (atoms / isotope) has a mass of (exactly) 12 g	**2**

Question	Answer	Marks
2(a)(ii)	**M1** identification of the IMF between F_2 molecules and between HCl molecules HCl has (permanent) dipoles and / or induced dipoles F_2 has induced dipoles **M2** comparison of strength of IMF's in F_2 and HCl Intermolecular forces in HCl are stronger than F_2	2
2(a)(iii)	strong (electrostatic) forces of attraction between (oppositely charged) ions	1
2(a)(iv)	$CaCO_3(s) + 2HF(aq) \rightarrow CaF_2(aq) + CO_2(g) + H_2O(l)$ **M1** species and balancing **M2** state symbols	2
2(b)(i)	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$	1
2(b)(ii)	**M1** purple gas / vapour disappears **M2** iodine is not a strong enough oxidising agent ORA	2
2(b)(iii)	**M1** silver nitrate / $AgNO_3$ **M2** yellow	2
2(b)(iv)	(aqueous) ammonia / $NH_3(aq)$ / ammonium hydroxide / $NH_4OH(aq)$	1
2(c)(i)	 **M1** bonding pairs correct **M2** rest of molecule, incl. lone pairs.	2
2(c)(ii)	$F_2 + H_2O \rightarrow HF + HOF$	1

Question	Answer	Marks
2(c)(iii)	**M1** labelled reactants **AND** products lower on right **M2** labelled enthalpy change with correct arrow	2
2(c)(iv)	$\overset{\delta+}{H}-\overset{\delta-}{F}$: ⋯⋯ $\overset{\delta+}{H}-\overset{\delta-}{F}$ **M1** H-bond labelled / shown as distinct from H—F bond **M2** correct sequence of three correct dipoles **M3** lone pair on F in line with H-bond	3
2(d)(i)	$pV = nRT \therefore n = \frac{pV}{RT} = \frac{101\,325 \times 0.001}{8.31 \times 273} = 0.0447$ mol $\therefore M_r = \frac{m}{n} = \frac{4.13}{0.0447} = 92.4$ or 92.5 **M1** Use of T = 273 K, V = 0.001 m^3 and p = 101325 Pa **M2** correct use of $pV = nRT$ using values from M1 **M3** correct calculation of M_r using 4.13 ÷ moles from M2	3
2(d)(ii)	ClF_3	1

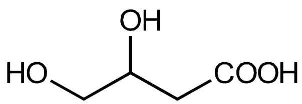
<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>3(e)</td><td>
<table>
<tr><th></th><th>P</th><th>Q</th><th>R</th></tr>
<tr><td>Na(s)</td><td>effervescence</td><td>no reaction</td><td>no reaction</td></tr>
<tr><td>2,4-DNPH</td><td>no reaction</td><td>orange ppt</td><td>orange ppt</td></tr>
<tr><td>acidified $K_2Cr_2O_7$(aq)</td><td>no reaction</td><td>no reaction</td><td>(turns) green</td></tr>
</table>
</td><td>3</td></tr>
<tr><td>3(b)</td><td>$C_5H_{10}O + 2[H] \rightarrow C_5H_{12}O$</td><td>1</td></tr>
<tr><td>3(c)</td><td>M1 geometric(al)

M2
</td><td>2</td></tr>
<tr><td>3(d)</td><td>M1 compound P

M2 (absorption at) 2250 cm^{-1} AND C≡N (stretch)

M3 (absorption at) 3100–3700 cm^{-1} AND O—H (stretch)</td><td>3</td></tr>
</table>

Question	Answer	Marks
4(a)	3-chloroprop-1-ene	1
4(b)(i)	ultra-violet (light) / sun(light)	1
4(b)(ii)	$CH_2{=}CHCH_3 + Cl\bullet \rightarrow CH_2{=}CHCH_2\bullet + HCl$ OR $C_3H_6 + Cl\bullet \rightarrow C_3H_5\bullet + HCl$	1

Question	Answer	Marks
4(b)(iii)	free-radical (substitution) reactions are uncontrolled OR further chlorination / substitution occurs	**1**
4(b)(iv)	$SOCl_2$ OR PCl_5 OR PCl_3 OR c(oncentrated) HCl	**1**
4(c)(i)	cold, dilute acidified $KMnO_4$ / potassium manganate(VII)	**1**
4(c)(ii)	**M1** catalyst **M2** ethanoic acid / CH_3CO_2H	**2**
4(c)(iii)	nucleophilic substitution / S_N2	**1**
4(c)(iv)	 **M1** hydrolysed nitrile on straight-chain 4C backbone **M2** 3,4-diol	**2**
4(d)	**M1** major product formed from more stable intermediate / carbocation OR (intermediate has) 2°carbocation which is (more) stable **M2** (positive) inductive effect / (+)I of alkyl groups (on the intermediate)	**2**