Cambridge International AS & A Level

Cambridge Assessment International Education
Cambridge International Advanced Subsidiary and Advanced Level

CHEMISTRY **9701/22**

Paper 2 AS Structured Questions **October/November 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.

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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.

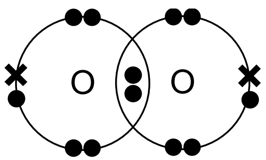
GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely 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)(i)		**1**
1(a)(ii)	$Si(g) \rightarrow Si^{+}(g) + e^{-}$	**1**
1(a)(iii)	**M1:** similar shielding AND increase in proton number / atomic number / nuclear charge **M2:** increased nuclear attraction	**2**
1(a)(iv)	**M1:** 3 **OR** 13 **M2:** large(r) *increase* between third and fourth ionisation energies **OR** large(r) *increase* after third electron removed	**2**
1(b)(i)	**M1:** $\frac{(92.2 \cdot 28) + ({}^{29}Si \cdot 29) + ({}^{30}Si \cdot 30)}{100} = 28.09$ **M2:** (x =) 6.6 **OR** 28.09 = 28.078 + x (where x = abundance of Si-29) **M3:** *7.8 – M2 calculated correctly to one decimal place (or more)* (=) 1.2%	**3**
1(b)(ii)	**M1** giant (molecule) **M2** strong covalent bonds (between atoms / particles) **M3** no mobile charged particles / carriers	**3**
1(c)(i)	$C_2H_5SH + 4\frac{1}{2}O_2 \rightarrow 2CO_2 + 3H_2O + SO_2$	**1**

Question	Answer	Marks
1(c)(ii)	**M1:** (causes) acid rain OR reacts/dissolves with (rain)water (vapour) to form (sulfuric / sulfurous) acid **M2:** one point from the following list. lowers pH / increases acidity of rivers / lakes / oceans / water supplies / seas / soil / ground water kills/harms / damages fish kills / harms / damages plants / damages coral / aquatic life / plants / crops / trees or deforestation leaches (toxic) aluminium (ions / salts) from soil (into rivers / lakes) leaches away soil nutrients / soil unfit for agriculture damages / weathers / erodes / destroys buildings / statues	**2**
1(d)(i)	**M1:** no effect / none **M2:** equal mol(es) (*of gas*) on both sides (of equilibrium / equation) owtte	**2**
1(d)(ii)	**M1:** (forward reaction is) endothermic **M2:** Any temperature higher than 300 K	**2**

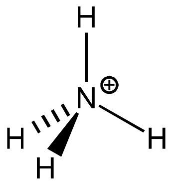
<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(a)</td><td>
<table>
<tr><td>Na_2O</td><td>Al_2O_3</td><td>SiO_2</td><td>P_4O_{10} / P_4O_6 / P_2O_3 / P_2O_5</td><td>SO_3</td></tr>
<tr><td>basic</td><td>amphoteric</td><td>acidic</td><td>acidic</td><td>acidic</td></tr>
</table>
M1: all formulae correct

M2: all acid / base behaviour correctly stated</td><td>2</td></tr>
<tr><td>2(b)(i)</td><td>reacts with both acid and base</td><td>1</td></tr>
<tr><td>2(b)(ii)</td><td>$OH^- + H^+ \rightarrow H_2O$</td><td>1</td></tr>
<tr><td>2(b)(iii)</td><td>reaction with strontium / reaction 1 will effervesce / fizz / bubble
OR
no fizzes / bubbles / effervescence with SrO</td><td>1</td></tr>
<tr><td>2(b)(iv)</td><td>increases</td><td>1</td></tr>
<tr><td>2(c)(i)</td><td>M1: correct conversion of quantities
$V = 5(.00) \cdot 10^{-4}$ (m^3)
$T = 293$ (K)
$p = 5.37(0) \cdot 10^3$ (Pa)

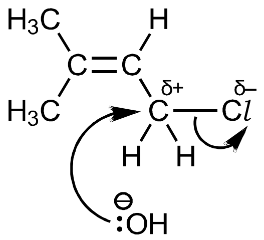
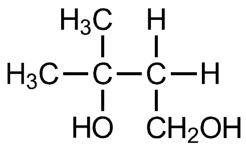
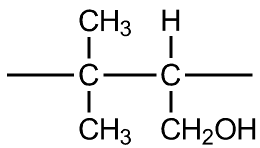
M2: calculation to find n using n = PV / RT
(n) = $1.1 \cdot 10^{-3}$ (mol)</td><td>2</td></tr>
<tr><td>2(c)(ii)</td><td>(i) $\cdot$ 78 = 0.0860 g</td><td>1</td></tr>
<tr><td>2(c)(iii)</td><td>

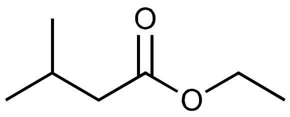
M1: bonding pair between the two O

M2: total of 14 electrons distributed equally between the two O</td><td>2</td></tr>
</table>

Question	Answer	Marks
3(a)(i)	green gas fades **OR** white solid / white powder / white smoke / white fumes	**1**
3(a)(ii)	hydrolysis	**1**
3(a)(iii)	P goes from 0 to (+)5 / (+)V P is oxidised N goes from (+)5 / (+)V to (+)4 / (+)IV N is reduced Award one mark for two correct bullet points, award two marks for all four correct.	**2**
3(b)(i)	accepts a proton / H^+ **OR** donates a (lone) pair of e^-	**1**
3(b)(ii)	*3-D shape **AND** bond angle*  **AND** $109\frac{1}{2}$ (°)	**1**
3(b)(iii)	fertilisers	**1**
3(c)(i)	$C_2H_5OH + PCl_5 \rightarrow C_2H_5Cl + POCl_3 + HCl$	**1**
3(c)(ii)	substitution	**1**

Question	Answer	Marks
3(c)(iii)	EITHER **M1:** HI **/** I^- is a strong(er) reducing agent (than HC*l* / C*l*$^-$) **M2:** HI **/** I^- is oxidised (to iodine but the chloride is not) **OR** **M1:** H_2SO_4 is a (strong enough) oxidising agent (to react with HI **/** I^- here) **M2:** HI **/** I^- forms iodine **OR** **M1:** phosphoric acid is a weak / not an oxidising agent **M2:** (so) does not react with iodide (where M2 is dependent on M1 here)	**2**
3(c)(iv)	**M1:** C_2H_5I reacts fastest AND C_2H_5Cl reacts slowest **OR** C_2H_5Cl < C_2H_5Br < C_2H_5I **M2:** C—I bond is the weak(est) AND C—C*l* bond strong(est)	**2**

Question	Answer	Marks
4(a)	 **M1:** curly arrow from lone pair on O of OH^- to C of C—C*l* **M2:** correct dipole on C—C*l* **AND** curly arrow from C—C*l* bond to $Cl^{\delta-}$	**2**
4(b)(i)		**1**
4(b)(ii)	$(CH_3)_2CHCH(OH)CH_2OH$	**1**
4(b)(iii)	optical (isomerism)	**1**
4(b)(iv)	$C_5H_{12}O_2 + 3[O] \rightarrow C_5H_8O_3 + 2H_2O$	**1**
4(c)(i)	Add bromine water / $Br_2(aq)$ **AND** turns (from orange / brown to) colourless	**1**
4(c)(ii)		**1**
4(d)(i)	3-methylbutan-1-ol	**1**
4(d)(ii)	heterogeneous	**1**

Question	Answer	Marks
4(d)(iii)	**M1:** skeletal formula of Q  ONLY **M2: one** commercial use of Q (ethyl isovalerate / ethyl 3methylbutyrate) solvents / perfumes / flavourings	**2**
4(e)(i)	1500–1680 (cm^{-1}) **AND** C=C	**1**
4(e)(ii)	potassium cyanide / KCN / sodium cyanide / NaCN	**1**
4(e)(iii)	(acidic) hydrolysis	**1**
4(e)(iv)	**M1:** recognise this reaction involves less stable intermediate 1° (carbo)cation (intermediate) is less stable (than 3°) **M2:** explain difference in reactivity in terms of positive inductive effect – comparative answer low**er** (positive) inductive effect / lower (+)I **OR** inductive effect of **less** alkyl groups	**2**