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**CHEMISTRY**

**9701/22**

Paper 2 AS Level Structured Questions

**May/June 2019**

MARK SCHEME

Maximum Mark: 60

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**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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This document consists of **12** printed pages.

**PUBLISHED****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.

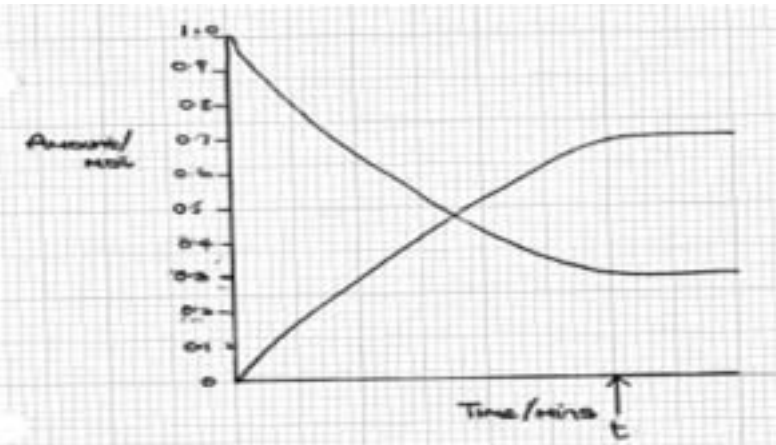
**GENERIC MARKING PRINCIPLE 5:**

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)	C <sub>4</sub> H <sub>10</sub> / same molecular formula / OR same number of carbon (atoms) and hydrogen (atoms)	<b>1</b>
	different structural formula OR description of different structural formula which does not imply stereoisomerism	<b>1</b>
1(a)(ii)	structural / chain	<b>1</b>
1(b)	(forward reaction is) exothermic reaction	<b>1</b>
	the proportion of methylpropane / product decreases OR the proportion of butane / reactant increases	<b>1</b>

Question	Answer	Marks
1(c)(i)	<p><math>t</math> shown on graph which corresponds to start of the horizontal part of both curves.</p> 	1
1(c)(ii)	<p>concentration of butane = <math>0.3 \text{ mol dm}^{-3}</math></p> <p>AND</p> <p>concentration of methylpropane = <math>0.7 \text{ mol dm}^{-3}</math></p>	1
1(c)(iii)	<p><math>[\text{methylpropane}] / [\text{butane}]</math></p> <p>OR</p> <p><math>[(\text{CH}_3)_2\text{CHCH}_3] / [\text{CH}_3(\text{CH}_2)_2\text{CH}_3]</math></p>	1

Question	Answer	Marks
1(c)(iv)	<b>M1</b> value for $K_c$ $K_c = \frac{\text{value of methylpropane in (ii)}}{\text{value of butane in (ii)}} = 0.7 / 0.3 = 2.3$ (3)	1
	<b>M2</b> units consistent with expression used in M1 no units / dimensionless / none	1

Question	Answer	Marks
2(a)	<i>trend in volatility down the group</i> decrease (in volatility)	1
	<i>identification of specific IMF increasing</i> increasing (strength of) induced dipole (id) (interactions between molecules)	1
	<i>explanation in terms of electrons</i> increasing number of electrons	1
2(b)(i)	<i>Conditions for reaction with <math>Cl_2</math> at room temperature</i> ultra-violet / uv	1

Question	Answer	Marks
2(b)(ii)	$\text{I}_2(\text{g} / \text{s}) + \text{H}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g})$ <p><b>M1</b> correctly balanced equation</p>	<b>1</b>
	<b>M2</b> correct state symbols AND use of <u>equilibrium</u> sign	<b>1</b>
2(c)(i)	proton / $\text{H}^+$ donor	<b>1</b>
2(c)(ii)	acid $\text{HCl}$ AND conjugate base $\text{Cl}^-$	<b>1</b>
2(c)(iii)	co-ordinate / dative (covalent)	<b>1</b>
2(c)(iv)	(triangular / trigonal) pyramid(al)	<b>1</b>
	$107^{(0)}$	<b>1</b>

Question	Answer	Marks								
3(a)(i)	$\text{SiCl}_4(l) + 2\text{H}_2\text{O}(l) \rightarrow \text{SiO}_2(s) + 4\text{HCl}(aq/g)$ (state symbols required)	1								
3(a)(ii)	hydrolysis	1								
3(a)(iii)	NaCl – ionic	1								
	SiCl <sub>4</sub> – covalent	1								
3(a)(iv)	<b>M1</b> statement correctly comparing the <b>difference</b> in electronegativity between Si and Cl AND Na and Cl  OR  Na is less electronegative than Si OR	1								
	<b>M2</b> NaCl transfer of electrons	1								
	<b>M3</b> SiCl <sub>4</sub> shared (pair of) electrons	1								
3(b)(i)	<table border="1" data-bbox="322 847 981 1046"> <tbody> <tr> <td data-bbox="322 847 698 948">Chlorine containing species</td> <td data-bbox="698 847 777 948">Cl<sub>2</sub></td> <td data-bbox="777 847 869 948">HCl</td> <td data-bbox="869 847 981 948">HOCl</td> </tr> <tr> <td data-bbox="322 948 698 1046">Oxidation number of chlorine</td> <td data-bbox="698 948 777 1046">0</td> <td data-bbox="777 948 869 1046">–1</td> <td data-bbox="869 948 981 1046">(+1)</td> </tr> </tbody> </table> Award 2 marks for 3 correct oxidation numbers  Award 1 Mark for 2 correct oxidation numbers	Chlorine containing species	Cl <sub>2</sub>	HCl	HOCl	Oxidation number of chlorine	0	–1	(+1)	2
Chlorine containing species	Cl <sub>2</sub>	HCl	HOCl							
Oxidation number of chlorine	0	–1	(+1)							
3(b)(ii)	disproportionation	1								
3(b)(iii)	kills micro-organisms	1								



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Question	Answer	Marks
3(c)	$2\text{NaOH} + \text{HCl} + \text{HClO} \rightarrow \text{NaCl} + \text{NaClO} + 2\text{H}_2\text{O}$  <b>M1</b> Identifies the product NaClO  <b>M2</b> Correctly balances the equation  OR  The overall equation may be seen as: $\text{NaOH} + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O}$ <b>AND</b> $\text{NaOH} + \text{HClO} \rightarrow \text{NaClO} + \text{H}_2\text{O}$	<b>2</b>

Question	Answer	Marks
4(a)	name of source crude oil / petroleum	<b>1</b>
	outline of separation of hydrocarbons (separation of molecules according to) different boiling points	<b>1</b>
4(b)(i)	cracking	<b>1</b>
4(b)(ii)	$2\text{C}_7\text{H}_{16} \rightarrow \text{C}_4\text{H}_{10} + \text{C}_6\text{H}_{14} + 2\text{C}_2\text{H}_4$	<b>1</b>

Question	Answer	Marks		
4(c)	<i>method 1</i>	<i>method 2</i>		
	<b>M1</b>	$1 / 28 (= 0.035714)$	$1 : 88 / 28 (= 3.14286)$	<b>1</b>
	<b>M2</b>	$2 \times M1 (= 1 / 14 = 0.07143)$	$M1 / 44 (= 0.071429)$	<b>1</b>
	<b>M3</b>	$M2 \times 24 = 1.7 \text{ dm}^3$	$M2 \times 24 = 1.7 \text{ dm}^3$	<b>1</b>
4(d)(i)	unpaired electron(s)	<b>1</b>		
4(d)(ii)	homolytic (fission)	<b>1</b>		
	one electron goes to each chlorine / atom  OR  pair of electrons is shared out (equally between the two atoms)	<b>1</b>		
4(d)(iii)	propagation	<b>1</b>		
4(d)(iv)	$\text{CH}_4 + (\bullet)\text{Cl} \rightarrow (\bullet)\text{CH}_3 + \text{HCl}$ <b>OR</b> $\text{CH}_4 + (\bullet)\text{Cl} \rightarrow \text{HCl} + \text{CH}_3(\bullet)$	<b>1</b>		

Question	Answer	Marks
4(d)(v)	<p><b>M1</b> identify bond types in alkanes and alkenes</p> <p>bonds in alkanes are (all) sigma / <math>\sigma</math></p> <p>AND</p> <p>alkenes have (C = C made of) sigma AND pi / <math>\sigma</math> AND <math>\pi</math></p>	1
	<p><b>M2</b> electrons in <math>\pi</math> (of the C = C) are responsible for the reaction</p> <p>electrophiles are attracted to / attack to electrons in <b>pi</b> / <math>\pi</math></p> <p>OR</p> <p>electrophiles react with <b>pi</b> / <math>\pi</math></p>	1

Question	Answer	Marks
5(a)(i)	(n-)propyl ethanoate	1
5(a)(ii)	NaOH / sodium hydroxide	1
5a(iii)	$  \begin{array}{ccccccc}  & \text{H} & \text{H} & \text{H} & & & \\  &   &   &   & & & \\  \text{H} & -\text{C} & -\text{C} & -\text{C} & -\text{O} & & \\  &   &   &   & & \backslash & \\  & \text{H} & \text{H} & \text{H} & & & \text{H}  \end{array}  $	1
5(a)(iv)	perfume / solvent	1

Question	Answer	Marks
5(b)(i)	<b>M1</b> divide by $A_r$ <div style="display: flex; justify-content: space-around; width: 100%;"> <span>C</span> <span>H</span> <span>O</span> </div> <div style="display: flex; justify-content: space-around; width: 100%;"> <span>54.5 / 12</span> <span>9.1 / 1</span> <span>36.4 / 16</span> </div>	<b>1</b>
	<b>M2</b> divide by smallest number <div style="display: flex; justify-content: space-around; width: 100%;"> <span>4.54 / 2.275 (= 2 OR 1.99)</span> <span>9.1 / 2.275(=4)</span> <span>2.275 / 2.275 (=1)</span> </div>	<b>1</b>
	<b>M3</b> empirical formula based on correctly rounded values of M2 <div style="text-align: center; margin-top: 10px;">C<sub>2</sub>H<sub>4</sub>O</div>	<b>1</b>
5(b)(ii)	(relative) molecular mass / $M_r$	<b>1</b>
5(c)(i)	C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	<b>1</b>
5(c)(ii)	X and Z – no reaction / no (visible) change	<b>1</b>
	Y – effervesces	<b>1</b>
5(d)	$2\text{HCO}_2\text{H} + \text{Na}_2\text{CO}_3 \rightarrow 2\text{HCO}_2\text{Na} + \text{CO}_2 + \text{H}_2\text{O}$	<b>1</b>