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 **May/June 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 May/June 2019 series for most Cambridge IGCSE™, Cambridge International A and AS Level and Cambridge Pre-U 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.

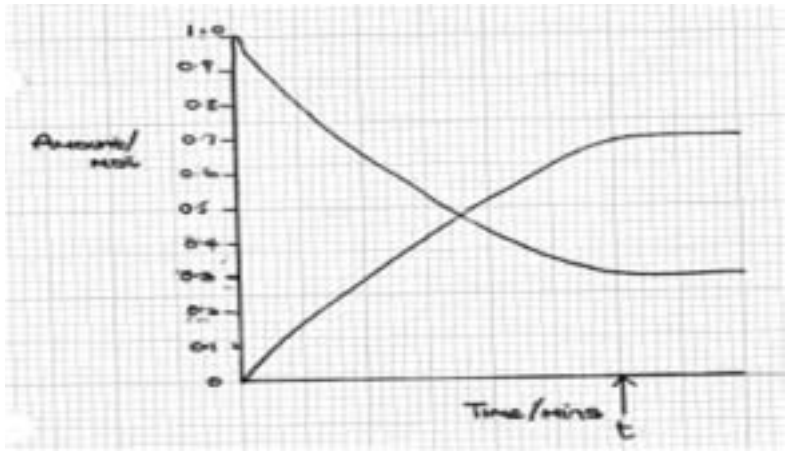
GENERIC MARKING PRINCIPLE 5:

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_4H_{10} / same molecular formula / OR same number of carbon (atoms) and hydrogen (atoms)	**1**
	different structural formula OR description of different structural formula which does not imply stereoisomerism	**1**
1(a)(ii)	structural / chain	**1**
1(b)	(forward reaction is) exothermic reaction	**1**
	the proportion of methylpropane / product decreases OR the proportion of butane / reactant increases	**1**

Question	Answer	Marks
1(c)(i)	*t* shown on graph which corresponds to start of the horizontal part of both curves. 	**1**
1(c)(ii)	concentration of butane = 0.3 mol dm^{-3} AND concentration of methylpropane = 0.7 mol dm^{-3}	**1**
1(c)(iii)	[methylpropane] / [butane] OR $[(CH_3)_2CHCH_3]$ / $[CH_3(CH_2)_2CH_3]$	**1**

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

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

Question	Answer	Marks
2(b)(ii)	$I_2(g/s) + H_2(g) \rightleftharpoons 2HI(g)$ **M1** correctly balanced equation	**1**
	M2 correct state symbols AND use of equilibrium sign	**1**
2(c)(i)	proton / H^+ donor	**1**
2(c)(ii)	acid HCl AND conjugate base Cl^-	**1**
2(c)(iii)	co-ordinate / dative (covalent)	**1**
2(c)(iv)	(triangular / trigonal) pyramid(al)	**1**
	$107^{(0)}$	**1**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>3(a)(i)</td><td>$SiCl_4(l) + 2H_2O(l) \rightarrow SiO_2(s) + 4HCl(aq/g)$
(state symbols required)</td><td>1</td></tr>
<tr><td>3(a)(ii)</td><td>hydrolysis</td><td>1</td></tr>
<tr><td rowspan="2">3(a)(iii)</td><td>$NaCl$ – ionic</td><td>1</td></tr>
<tr><td>$SiCl_4$ – covalent</td><td>1</td></tr>
<tr><td rowspan="3">3(a)(iv)</td><td>M1 statement correctly comparing the difference in electronegativity between Si and Cl AND Na and Cl

OR

Na is less electronegative that Si ORA</td><td>1</td></tr>
<tr><td>M2 $NaCl$ transfer of electrons</td><td>1</td></tr>
<tr><td>M3 $SiCl_4$ shared (pair of) electrons</td><td>1</td></tr>
<tr><td>3(b)(i)</td><td><table><tr><td>Chlorine containing species</td><td>Cl_2</td><td>HCl</td><td>$HOCl$</td></tr><tr><td>Oxidation number of chlorine</td><td>0</td><td>–1</td><td>(+)1</td></tr></table>
Award 2 marks for 3 correct oxidation numbers

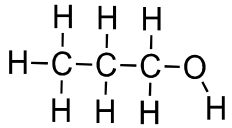
Award 1 Mark for 2 correct oxidation numbers</td><td>2</td></tr>
<tr><td>3(b)(ii)</td><td>disproportionation</td><td>1</td></tr>
<tr><td>3(b)(iii)</td><td>kills micro-organisms</td><td>1</td></tr>
</table>

Question	Answer	Marks
3(c)	$2NaOH + HCl + HClO \rightarrow NaCl + NaClO + 2H_2O$ **M1** Identifies the product NaClO **M2** Correctly balances the equation OR The overall equation may be seen as: $NaOH + HCl \rightarrow NaCl + H_2O$ **AND** $NaOH + HClO \rightarrow NaClO + H_2O$	**2**

Question	Answer	Marks
4(a)	name of source crude oil / petroleum	**1**
	outline of separation of hydrocarbons (separation of molecules according to) different boiling points	**1**
4(b)(i)	cracking	**1**
4(b)(ii)	$2C_7H_{16} \rightarrow C_4H_{10} + C_6H_{14} + 2C_2H_4$	**1**

Question	Answer			Marks
4(c)		*method 1*	*method 2*	
	M1	1 / 28 (= 0.035714)	1 : 88 / 28 (= 3.14286)	**1**
	M2	2 × M1 (= 1 / 14 = 0.07143)	M1 / 44 (= 0.071429)	**1**
	M3	M2 × 24 = 1.7 dm^3	M2 × 24 = 1.7 dm^3	**1**
4(d)(i)	unpaired electron(s)			**1**
4(d)(ii)	homolytic (fission)			**1**
	one electron goes to each chlorine / atom OR pair of electrons is shared out (equally between the two atoms)			***1***
4(d)(iii)	propagation			**1**
4(d)(iv)	$CH_4 + (\bullet)Cl \rightarrow (\bullet)CH_3 + HCl$ **OR** $CH_4 + (\bullet)Cl \rightarrow HCl + CH_3(\bullet)$			**1**

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

Question	Answer	Marks
5(a)(i)	(n–)propyl ethanoate	**1**
5(a)(ii)	NaOH / sodium hydroxide	**1**
5a(iii)		**1**
5(a)(iv)	perfume / solvent	**1**

Question	Answer				Marks
5(b)(i)	**M1** *divide by A_r*	C	H	O	**1**
		54.5 / 12	9.1 / 1	36.4 / 16	
	M2 *divide by smallest number*				**1**
		4.54 / 2.275 (= 2 OR 1.99)	9.1 / 2.275(=4)	2.275 / 2.275 (=1)	
	M3 *empirical formula based on correctly rounded values of M2*				**1**
			C_2H_4O		
5(b)(ii)	(relative) molecular mass / M_r				**1**
5(c)(i)	$C_3H_6O_2$				**1**
5(c)(ii)	X and Z – no reaction / no (visible) change				**1**
	Y – effervesces				**1**
5(d)	$2HCO_2H + Na_2CO_3 \rightarrow 2HCO_2Na + CO_2 + H_2O$				**1**