Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CHEMISTRY **9701/42**

Paper 4 A Level Structured Questions **March 2017**

MARK SCHEME

Maximum Mark: 100

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.

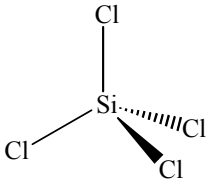
Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the March 2017 series for most Cambridge IGCSE®, Cambridge International A and AS Level components and some Cambridge O Level components.

® IGCSE is a registered trademark.

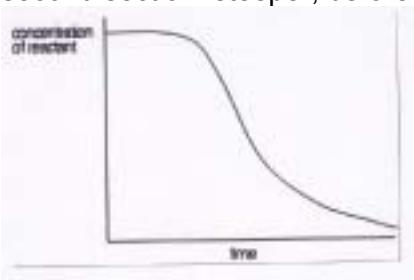
© UCLES 2017

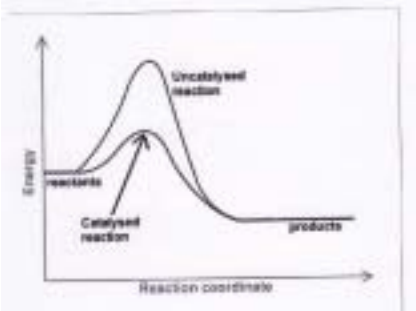
Question	Answer	Marks
1(a)(i)	$(28 \times 0.922) + (29 \times 0.047) + (30 \times 0.031) = 28.11$	**1**
1(a)(ii)	$SiCl_4 + 4H_2O \rightarrow Si(OH)_4 + 4HCl$	**1**
1(a)(iii)	 diagram	**1**
	bond angle = 109.5	**1**
1(a)(iv)	SiO_2	**1**
	SiO_2 is giant covalent / molecular but $SiCl_4$ is simple molecular / covalent	**1**
1(b)(i)	$2\mathbf{A}(NO_3)_2 \rightarrow 2\mathbf{A}O + 4NO_2 + O_2$ correct formula balanced equation	**2** 1 1
1(b)(ii)	giant ionic	**1**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(a)</td><td>
<table>
<tr><td>enthalpy change</td><td>positive</td><td>negative</td><td>either positive or negative</td></tr>
<tr><td>electron affinity</td><td></td><td></td><td>✓</td></tr>
<tr><td>enthalpy change of atomisation</td><td>✓</td><td></td><td></td></tr>
<tr><td>enthalpy change of ionisation</td><td>✓</td><td></td><td></td></tr>
<tr><td>lattice enthalpy</td><td></td><td>✓</td><td></td></tr>
</table>
</td><td>2</td></tr>
<tr><td>2(b)(i)</td><td>the second electron is removed from a (more) positively charged ion</td><td>1</td></tr>
<tr><td>2(b)(ii)</td><td>ΔH_6 is lattice (energy / enthalpy) AND ΔH_7 is (energy / enthalpy of) formation</td><td>1</td></tr>
<tr><td rowspan="2">2(c)</td><td>the electron affinity becomes less exothermic / negative down the Group 17</td><td>1</td></tr>
<tr><td>electron affinity depends (mainly) on the electron-nucleus distance which increases down Group 17</td><td>1</td></tr>
<tr><td rowspan="4">2(d)</td><td>M1 correct use of $\Delta G = \Delta H - T\Delta S$</td><td>1</td></tr>
<tr><td>M2 $\Delta S = 26.9 - (32.7 + 102.5) = -108.3\,J\,K^{-1}\,mol^{-1}$ OR $-0.1083\,kJ\,K^{-1}\,mol^{-1}$</td><td>1</td></tr>
<tr><td>M3 $\Delta G = -602 - (298 \times (-0.1083)) = -570$</td><td>1</td></tr>
<tr><td>M4 units: $kJ\,mol^{-1}$</td><td>1</td></tr>
</table>

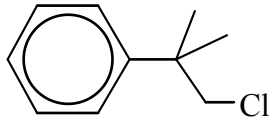
© UCLES 2017

Question	Answer	Marks
3(a)(i)	**A** – H_2, 1 atm **B** – platinum **C** – 1 mol dm^{-3} H^+ / HC*l* etc. **D** – salt bridge / KNO_3 etc. **E** – platinum **F** – 1 mol dm^{-3} Fe^{2+} **AND** 1 mol dm^{-3} Fe^{3+}	**3**
3(a)(ii)	positive electrode is (Pt) on RHS **AND** electrons flow clockwise	**1**
3(b)	cell potential is 0.77 – 0.34 =(+) 0.43 (V)	**1**
3(c)(i)	electrode potential would become more negative as equilibrium shifts to left / explanation in terms of the Nernst equation	**1**
3(c)(ii)	E = –0.41 + (0.059/1)log$[Cr^{3+}]/[Cr^{2+}]$ = –0.41 + 0.059 log 4.0	**1**
	= –0.37 (V)	**1**

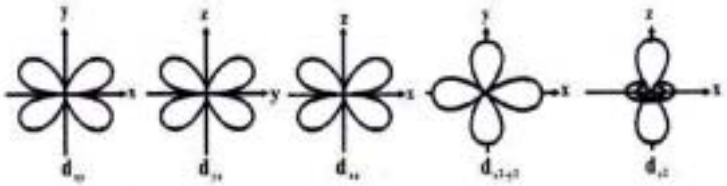
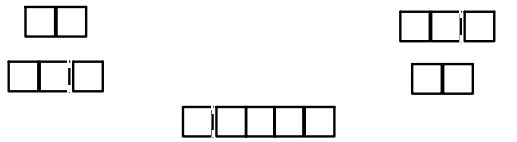
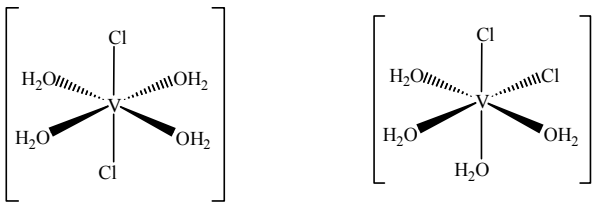
<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>4(a)(i)</td><td>experiments 1 and 2: doubling [ClO_2] quadruples the rate, so second order</td><td>1</td></tr>
<tr><td></td><td>experiments 2 and 3: doubling [OH^-] doubles the rate, so first order</td><td>1</td></tr>
<tr><td></td><td>rate equation = $k[ClO_2]^2[OH^-]$</td><td>1</td></tr>
<tr><td>4(a)(ii)</td><td>from experiment t 2: $9.34 \times 10^{-4} = k(2.50 \times 10^{-2})^2 \times 1.30 \times 10^{-3}$
$k = 1.15 \times 10^3$</td><td>1</td></tr>
<tr><td></td><td>units: $mol^{-2}dm^6\ s^{-1}$</td><td>1</td></tr>
<tr><td>4(b)(i)</td><td>heterogeneous catalysts are in different physical state from the reactants AND homogeneous catalysts are in the same physical state as the reactants</td><td>1</td></tr>
<tr><td>4(b)(ii)</td><td><table><tr><th>catalysed reaction</th><th>heterogeneous</th><th>homogeneous</th></tr><tr><td>manufacture of ammonia in the Haber process</td><td>✓</td><td></td></tr><tr><td>removal of nitrogen oxides from car exhausts</td><td>✓</td><td></td></tr><tr><td>oxidation of sulfur dioxide in the atmosphere</td><td></td><td>✓</td></tr></table></td><td>2</td></tr>
<tr><td>4(c)(i)</td><td>$2MnO_4^- + 6H^+ + 5(CO_2H)_2 \rightarrow 2Mn^{2+} + 10\ CO_2 + 8\ H_2O$
correct Mn : $(CO_2H)_2$ ratio
rest of equation</td><td>2
1
1</td></tr>
<tr><td>4(c)(ii)</td><td>first section: flatter
second section: steeper, before flattening
</td><td>2
1
1</td></tr>
</table>

Question	Answer	Marks
,4(d)(i)	 diagram catalyst lowers E_a for both the forward and reverse reactions so the process requires less energy / can occur at a lower temperature	**3** 1 1 1
4(d)(ii)	$K_p = (pNH_3)^2/(pN_2)(pH_2)^3$ $1.45 \times 10^{-5} = (pNH_3)^2 / 20 \times 60 \times 60 \times 60$	**1**
	$pNH_3 = 7.91$	**1**

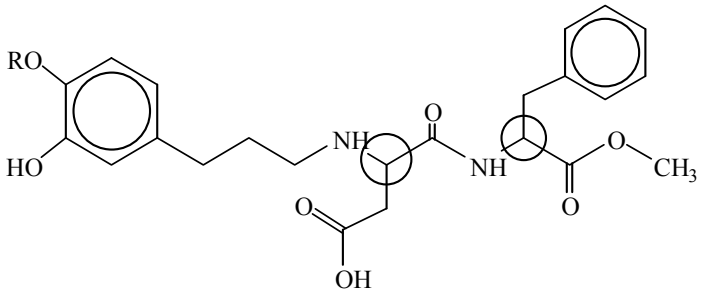
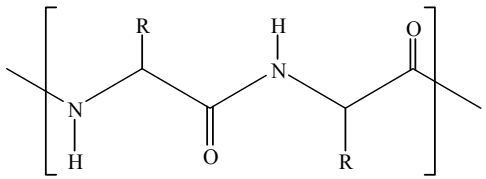
© UCLES 2017

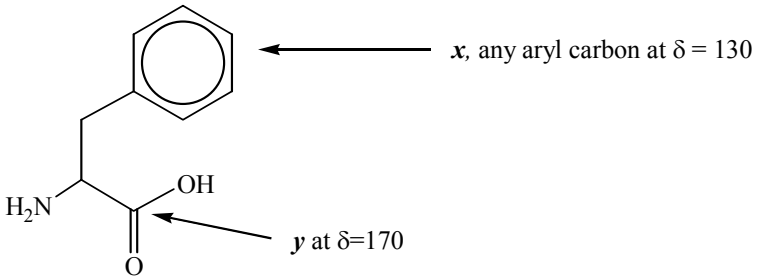
Question	Answer	Marks
5(a)(i)	$(CH_3)_3C\text{-}Cl$ / $(CH_3)_2C = CH_2$	**1**
	$AlCl_3$ + heat	**1**
5(a)(ii)	(UV) light	**1**
5(a)(iii)		**1**
5(a)(iv)	ammonia / NH_3	**1**
	heat in sealed tube / heat under pressure	**1**
5(b)	$C_{10}H_{13}NH_2 + H_3O^+ \rightleftharpoons C_{10}H_{13}NH_3^+ + H_2O$	**1**
5(c)	in compound **H**, the alkyl groups are electron donating / have a positive inductive effect, so it is more basic than NH_3	**1**
	in phenylamine, the lone pair (of N) is delocalised over the aryl group / benzene ring, so phenylamine is less basic than NH_3	**1**

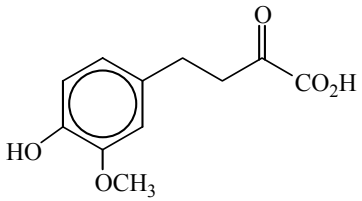
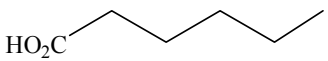
© UCLES 2017

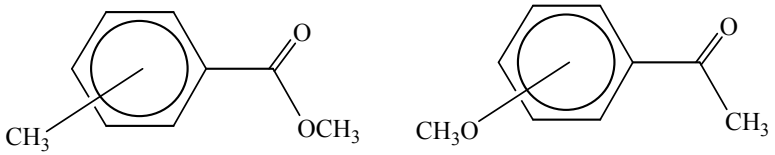
Question	Answer	Marks
6(a)(i)		**1**
6(a)(ii)	Ni : $[1s^2 2s^2 2p^6 3s^2 3p^6]$ **$3d^8 4s^2$** Ni^{3+} : $[1s^2 2s^2 2p^6 3s^2 3p^6]$ **$3d^7$**	**1**
6(b)(i)	 octahedral complex isolated ion tetrahedral complex	**1**
6(b)(ii)	energy / photon is absorbed in the visible region / light	**1**
	electron jumps from the lower to the upper energy level / is excited	**1**
6(b)(iii)	different frequency / wavelength of light are absorbed by the two complexes **OR** different size of energy gap	**1**
6(c)	colour of solution: green	**1**
	explanation: because the solution absorbs most strongly in the blue **AND** red regions	**1**
6(d)(i)		**2**

Question	Answer	Marks
6(d)(ii)	cis-trans / geometrical	**1**
6(e)(i)		**2**
6(e)(ii)	optical	**1**
6(f)(i)	$K_{stab} = [Ni(NH_3)_6{}^{2+}]/([Ni(H_2O)_6{}^{2+}][NH_3]^6)$	**1**
6(f)(ii)	$[Ni(en)_3]^{2+}$ would be formed because it is much more stable / K_{stab} is much greater **OR** in the presence of both ligands the overall equilibrium $[Ni(NH_3)_6]^{2+} \rightleftharpoons [Ni(H_2O)_6]^{2+} \rightleftharpoons [Ni(en)_3]^{2+}$ would shift right	**1**
6(f)(iii)	cis-trans isomers identified	**1**
	two cis isomers identified	**1**

Question	Answer	Marks
7(a)		**1**
7(b)(i)	$H^+(aq)$ + heat	**1**
7(b)(ii)	hydrolysis	**1**
7(b)(iii)	CH_3OH	**1**
7(c)(i)	white precipitate	**1**
7(c)(ii)	$C_{14}H_{19}O_6N + 3NaOH \rightarrow C_{14}H_{16}O_6NNa_3 + 3H_2O$	**2**
7(d)(i)	no change / colour remains orange	**1**
7(d)(ii)	 amide bond displayed **two** repeat units	**2** 1 1
7(e)(i)	seven	**1**

Question	Answer	Marks
7(e)(ii)		1

Question	Answer	Marks
8(a)	oxidation of –OH / alcohol to C=O / ketone / carbonyl	1
8(b)(i)	dehydration / elimination	1
8(b)(ii)	heat with Al_2O_3 **OR** heat with H_3PO_4 / H_2SO_4	1
8(b)(iii)	 **Q**  **R**	2
8(c)	phenol	1
	ketone	1

Question	Answer	Marks
9(a)(i)	n = 100 × (M+1)/(1.1 × M) = 100 × 3.4/(1.1 × 33.9) = 9.1	**1**
	hence 9 carbons atoms	**1**
9(a)(ii)	$C_9H_{10}O_2$	**1**
9(a)(iii)	(150 – 119 = 31), hence fragment is CH_3O	**1**
9(b)	**V** is C=O **AND W** is C–O	**1**
9(c)(i)	δ 3.9 is CH or alkyl / CH_3 next to oxygen **AND** δ 7.2–7.9 is CH / aryl hydrogens	**1**
9(c)(ii)	alkyl H next to C=O **AND** alkyl H next to aryl ring	**1**
9(c)(iii)	none of the functional groups in **T** contains a labile proton / **T** does not contain –OH or –NH groups.	**1**
9(d)		**2**

© UCLES 2017