Cambridge International AS & A Level

Cambridge Assessment International Education
Cambridge International Advanced Subsidiary and Advanced Level

CHEMISTRY	**9701/43**
Paper 4 A Level Structured Questions	**October/November 2019**
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 International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the October/November 2019 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

Cambridge Assessment International Education

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**:

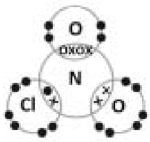
- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can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

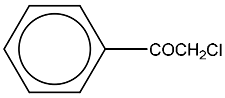
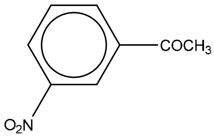
GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

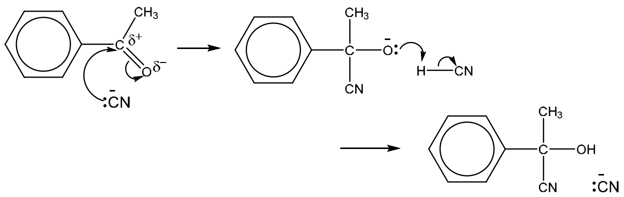
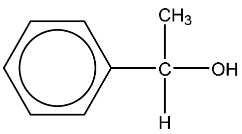
Question	Answer	Marks
1(a)	Platinum / Pt Aluminium / Al **BOTH**	**1**
1(b)(i)	**M1:** use of or quoting a valid Nernst equation $E = E^{\ominus} + 0.0590 / z \log [ox] / [red]$ ***OR*** $E = 0.15 + (0.0590 / 2)\log 2$ **M2:** E = (+)**0.16** (0.159) V minimum 2 sig. fig. correct answer scores 2 marks	**2**
1(b)(ii)	$E_{cell} = 0.16 – (–1.66) =$ **+1.82 V** minimum 3 sig. fig.	**1**
1(b)(iii)	$2Al + 3Sn^{4+} \rightarrow 2Al^{3+} + 3Sn^{2+}$ **M1:** species **M2:** balancing	**2**
1(c)	**M1:** number of C (= 300 000 × 60 × 60 × 24) = 2.59×10^{10} (C) **M2:** number of F(= $2.592 \times 10^{10} / 9.65 \times 10^{4}$) = 2.69×10^{5} (moles of electrons) **M3:** moles of Al (= $2.69 \times 10^{5} / 3$) = 8.95×10^{4} **M4:** mass of Al (= $8.95 \times 10^{4} \times 27$) = **2420 kg** correct answer scores 4 marks	**4**
1(d)	**M1:** ($Cr^{2+} + 2e^{-} \rightleftharpoons Cr$) $E^{\ominus} = –0.91$ **and** ($2H^{+} + 2e^{-} \rightleftharpoons H_2$) $E^{\ominus} = 0.00$ seen **M2:** hydrogen formed instead / hydrogen (ions) easier to reduce / hydrogen has more positive $E^{\ominus}$	**2**

Question	Answer	Marks
2(a)	 **M1:** eight electrons around N atom [N=O, N-O, N-C*l* with N-O as dative] **M2:** all other electrons correct	**2**
2(b)(i)	(rate =) k[C*l*NO_2][NO]	**1**
2(b)(ii)	$mol^{-1}\ dm^3\ s^{-1}$	**1**
2(b)(iii)	Yes **AND** number of moles of reactants in overall equation is the same as order in rate equation	**1**
2(c)(i)	• straight line with a negative gradient • starting at 2.0×10^{-4} • reaches at 1.8×10^{-4} at 0.2 seconds Award 1 mark for two points, award 2 marks for all three points	**2**
2(c)(ii)	2×10^{-5} ($mol\ dm^{-3}$)	**1**
2(c)(iii)	The reaction has reached equilibrium	**1**

Question	Answer	Marks
3(a)	a **measure / degree** of **disorder / randomness** of a system	**1**
3(b)	**M1:** negative – molecules have less energy in the system **M2:** positive – solid being converted into an aqueous solution **M3:** negative – gaseous ions being converted into a solid	**3**
3(c)(i)	(standard) Gibbs free energy <u>change</u>	**1**
3(c)(ii)	**M1:** $(\Delta)G = \Delta H - T\Delta S$ **M2:** description of calculating the minimum value of T for which ΔG is zero / becomes negative **OR** $T = \Delta H / \Delta S$ [1]	**2**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>4(a)</td><td>M1: CH_3COCl or ethanoyl chloride

M2: $AlCl_3$ catalyst</td><td>2</td></tr>
<tr><td>4(b)</td><td>
<table>
<tr><td>reagent</td><td>organic product</td><td>name of mechanism</td></tr>
<tr><td>Cl</td><td>
chlorine atom(s) in side chain only</td><td>free radical substitution</td></tr>
<tr><td>nitric / sulfuric</td><td>
one only $–NO_2$ group added at 3 position</td><td>electrophilic substitution</td></tr>
<tr><td>Br</td><td>no reaction with Br_2</td><td></td></tr>
</table>
Award 1 mark for each correct entry to the table [5]</td><td>5</td></tr>
<tr><td>4(c)(i)</td><td>nucleophilic addition</td><td>1</td></tr>
</table>

Question	Answer	Marks
4(c)(ii)	 **M1 and M2:** first structure – award one mark for two points correct, award two marks for four points correct. • correct polarity shown on C=O bond • curly arrow from double bond to O of the C=O • lone pair shown on C of CN^- ion • curly arrow from C (on CN^- ion) to C of C=O **M3:** middle structure • correct intermediate **AND** curly arrow from lone pair on O^- to H^+ **or** H of H_2O or HCN **M4**: third structure • correct product **AND** either CN^- reformed (if HCN seen in step 2) **OR** curly arrow on H-CN bond towards CN in step 2	4
4(d)(i)		1
4(d)(ii)	$LiAlH_4$ or $NaBH_4$	1
4(d)(iii)	**conc** H_2SO_4 / **conc** H_3PO_4 / Al_2O_3	1
4(d)(iv)	6	1

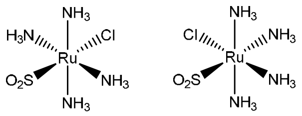
Question	Answer	Marks
4(d)(v)	• 25–50 • 110–160 • 190–220 Award 1 mark for two points, award 2 marks for three points	2

Question	Answer	Marks
5(a)(i)	$K_{sp} = [Ag^+]^2[S^{2-}]$	1
5(a)(ii)	• $[S^{2-}] = 1.16 \times 10^{-17}$ • $[Ag^+] = 2.32 \times 10^{-17}$ • $K_{sp} = \mathbf{6.2(4) \times 10^{-51}}$ minimum 2 sig. fig. correct answer scores 2 marks Award 1 mark for two points, award 2 marks for three points	2
5(a)(iii)	**M1**: moles Ag_2S = 1 / 247.9 = 0.00403 moles [1] 2sf min **M2**: $1.16 \times 10^{-17} = 0.0040 / V$ so V = $\mathbf{3.5 \times 10^{14}}$ (dm^3) [1] 2sf min ecf on M1 correct answer scores 2 marks	2
5(b)(i)	**M1:** $[H^+] = \sqrt{2.0 \times 10^{-9} \times 0.20}$ $[H^+] = 2.0 \times 10^{-5}$ (1.9976×10^{-5}) **M2:** pH = **4.7** (4.699) minimum 2 sig. fig. min correct answer scores 2 marks	2

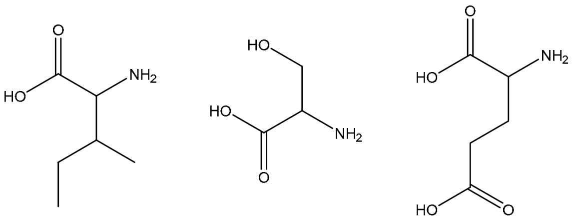
Question	Answer	Marks
5(b)(ii)	**M1: Both** equilibria correctly stated moles KOH = 0.005 × 0.2 = 1 × 10^{-3} moles HOBr(initial) = 0.020 × 0.2 = 4 × 10^{-3} moles HOBr(eqm) = 4 × 10^{-3} – 1 × 10^{-3} = **3** × **10^{-3}** moles BrO^-(eqm) = **1** × **10^{-3}** **M2:** ratio [OBr^-]/[HOBr] = 1/3 [H^+] = 3 × 2.0 × 10^{-9} = 6 × 10^{-9} pH = **8.2(2)** correct answer scores 2 marks	**2**

Question	Answer	Marks
6(a)(i)	$Mg(g) \rightarrow Mg^+(g) + e^-$	**1**
6(a)(ii)	$Sr(s) + 2H_2O(l) \rightarrow Sr(OH)_2(aq) + H_2(g)$	**1**
6(a)(iii)	more reactive **and** easier to ionise down the group **OR** more reactive **and** ionisation energies decrease down the group	**1**
6(b)(i)	brown gas **and white** solid	**1**
6(b)(ii)	$2Ca(NO_3)_2 \rightarrow 2CaO + 4NO_2 + O_2$	**1**
6(b)(iii)	**M1:** more stable (down the group) **M2:** cationic radius **increases /** charge density of M^{2+} decreases (down the group) **M3:** NO_3^- anion is less polarised / distorted	**3**

Question	Answer	Marks
6(c)	**M1:** less soluble / decreases (down the group) **M2:** ΔH_{latt} and ΔH_{hyd} **both** decrease / less exothermic down the group **M3:** ΔH_{hyd} decreases by more (than ΔH_{latt}) **M4:** ΔH_{sol} becomes more endothermic / less exothermic	**4**

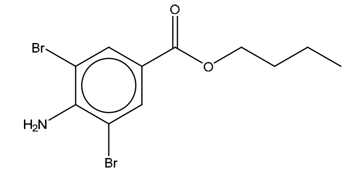
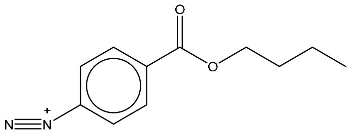
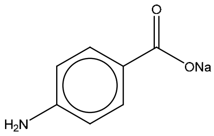
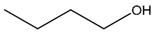
Question	Answer	Marks
7(a)	forms one or more stable ions with incomplete / partially filled d-orbitals / d-subshell	**1**
7(b)(i)	purple to pale pink / colourless **AND** orange to green	**1**
7(b)(ii)	$3Sn^{2+} + Cr_2O_7^{2-} + 14H^+ \rightarrow 3Sn^{4+} + 2Cr^{3+} + 7H_2O$	**1**
7(c)(i)	• six • coordinate bonds / dative bonds / lone pairs donated • to the (central) metal ion award 1 mark for all three points	**1**
7(c)(ii)	$[Ru(NH_3)_4Cl(SO_2)]^+$	**1**
7(c)(iii)	 **M1:** six correct ligands around Ru, bonds are shown from S of SO_2 **M2:** 3-D bonds used correctly for octahedral **M3:** cis and trans isomers shown	**3**

Question	Answer	Marks
7(c)(iv)	cis-trans or geometric(al) [1]	1
7(c)(v)	**M1:** complexes have two sets of **d orbital(s)** of different energy **OR d-orbitals** splits into two sets (of orbitals) **M2:** visible light **absorbed** (and complementary colour observed) **M3**: **electron**(s) promoted / excited **OR electron**(s) moves to higher (d–) orbital	3

Question	Answer	Marks
8(a)(i)	any one from: • OH^- / NaOH; aqueous / dilute; heat under reflux • H^+ / HC*l* / H_2SO_4, aqueous / dilute; heat under reflux • protease or named protease; water; T = 30° – 40°C all three points in each bullet [1]	1
8(a)(ii)	 M1: three amino acids in any ionic / non-ionic states [1] M2: three amino acids in the correct ionic state for their conditions [1]	2

Question	Answer	Marks
8(b)	• permanent dipole-dipole • one group that will have a δ⁺ and another with δ⁻ e.g. CO, NH, COOH, OH **BOTH** [1] • hydrogen bonds • one group that will have a $H^{\delta+}$, e.g. NH, OH and another with lone pair, e.g. NH, COOH, OH, $CONH_2$ **BOTH** [1] • ionic bonding • NH_3^+ **<u>and</u>** COO^- **BOTH** [1] **ALLOW** • London forces • C_4H_9 groups or parts of these alkyl groups	3
8(c)(i)	any structure containing one COOH / COC*l* **<u>and</u>** NH_2 groups in the same molecule [1]	1
8(c)(ii)	$HOCH_2CH_2OH$ [1] ethan(e)-1,2-diol [1] **ecf** for diols HO_2CCO_2H or C*l*OCCOC*l* [1] ethan(e)dioic acid or ethan(e)dioyl chloride [1] **ecf** for diacids / diacyl chlorides	4

Question	Answer	Marks
9(a)(i)	$RNH_2 + H^+ \rightarrow RNH_3^+$ **OR** $RNH_2 + HCl \rightarrow RNH_3Cl$ [1]	1
9(a)(ii)	weaker **AND** lone pair of N delocalised into benzene ring [1]	1

Question	Answer	Marks
9(b)	 [1]  [1]  **AND**  [1]	**3**
9(c)(i)	2 [1]	**1**
9(c)(ii)	CH_2 next to ester **and** terminal CH_3 are circled [1]	**1**
9(c)(iii)	• one less peak • the lost peak is NH_2 / aryl amine • protons exchange with D **OR** protons are labile **OR** valid equation •✓✓ for two marks [2]	**2**
9(d)	$C_6H_4NH_2^+$ **and** $CH_3CH_2CH_2CH_2^+$ [1]	**1**