Cambridge International AS & A Level

Cambridge Assessment International Education
Cambridge International Advanced Subsidiary and Advanced Level

CHEMISTRY **9701/42**

Paper 4 A Level Structured Qeustions **March 2018**

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.

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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.

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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.

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Question	Answer	Marks
1(a)(i)	(solubility) increases (down the group)	**1**
1(a)(ii)	*down the group:* lattice energy **or** hydration energy decrease lattice energy decreases more than hydration energy enthalpy change of solution becomes more negative / exothermic	**3**
1(b)(i)	$K_{sp} = [Sr^{2+}][OH^-]^2$	**1**
1(b)(ii)	$K_{sp} = (3.37 \times 10^{-2}) \times (6.74 \times 10^{-2})^2 = 1.5 \times 10^{-4}$ units: $mol^3\ dm^{-9}$	**2**
1(c)(i)	$2\ SrO_2 \longrightarrow 2SrO + O_2$	**1**
1(c)(ii)	temperature will increase (down the group) charge density of cation decreases (down the group) this means less polarisation of the O_2^{2-} ion *or* weakens the O-O bond less	**3**
1(d)(i)	$BaC_2O_4 \longrightarrow) BaO + CO + CO_2$	**1**
1(d)(ii)	the $KMnO_4$ would decolourise bubbles / gas evolution would be seen	**2**

Question	Answer	Marks
2(a)	the $E^\ominus$ for X_2 / X^- becomes less positive / decrease down the group so the halogens are less reactive (as oxidants) down the group	**2**
2(b)(i)	$Cl_2 + H_2O \longrightarrow HCl + HClO$	**1**
2(b)(ii)	Cl_2/Cl^- = +1.36 V **and** $ClO^- / (Cl^- + OH^-)$ = +0.89 V so $E^\ominus_{cell}$ = 1.36 – 0.89 = (+) 0.47 V	**2**

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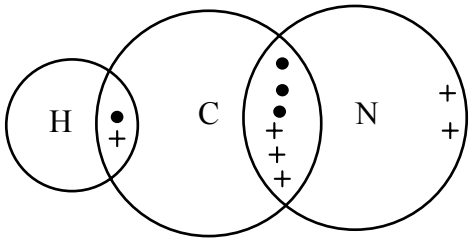
Question	Answer	Marks
2(b)(iii)	box three ticked Le Chatelier argument, more OH^- / increase reactant concentration so equilibrium shifts right *or* an argument based on the half cell with OH^-	**2**
2(c)(i)	$Br^- + 3ClO^- \longrightarrow BrO_3^- + 3Cl^-$	**1**
2(c)(ii)	$E^{\ominus}_{cell} = 0.89 - 0.58 = +0.31$ V	**1**
2(c)(iii)	$4HBrO_3 \longrightarrow 2Br_2 + 5O_2 + 2H_2O$	**1**

Question	Answer	Marks
3(a)(i)	$[H^+] = \sqrt{(K_a . c)} = \sqrt{(6.2 \times 10^{-10} \times 0.1)}$ $[H^+] = 7.9 \times 10^{-6}$ $pH = -\log[H^+] = 5.1(0)$	**2**
3(a)(ii)		**1**
3(a)(iii)	C: sp **and** N: sp angle 180°	**2**
3(a)(iv)	**A** is CH_3NH_2 **B** is HCO_2H	**2**
3(b)(i)	2-	**1**
3(b)(ii)	geometrical / cis-trans	**1**

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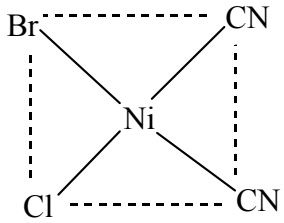
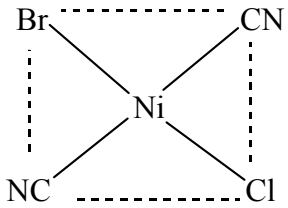
Question	Answer	Marks
3(b)(iii)	2 isomers   (must be clearly square planar)	**3**
3(c)	**C** is $Ni(CN)_2$ **D** is $K_2Ni(CN)_4$ **E** is $K_3Ni(CN)_5$	**3**

Question	Answer	Marks
4(a)(i)	(ratio of the) concentrations of a solute in two solvents / liquids at <u>equilibrium</u>	**1**
4(a)(ii)	$[NH_3]_{aq} = 0.1 \times 12.5 / 10 = 0.125$ mol dm^{-3} $[NH_3]_{CHCl_3} = 0.1 \times 13 / 25 = 0.052$ mol dm^{-3} ratio = $K_{partition}$ = 0.052 / 0.125 = 0.416	**2**
4(a)(iii)	$K_{partition}$ will be larger for butylamine than for ammonia butylamine contains a hydrophobic / non-polar (C_4) group	**2**
4(b)(i)	nitrogen has a lone pair which can accept a proton or can be donated to a proton	**1**
4(b)(ii)	e.g. $C_4H_9NH_2 + HCl \rightleftharpoons C_4H_9NH_3^+ + Cl^-$ etc.	**1**
4(b)(iii)	butanamide is non-basic / neutral *or* (much) less basic than butylamine	**1**
4(b)(iv)	$LiAlH_4$ (in dry ether)	**1**

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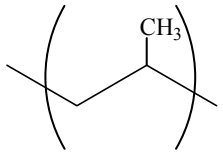
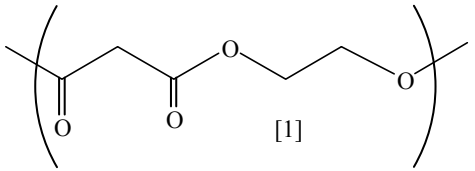
Question	Answer	Marks
5(a)(i)	$1s^2 2s^2 2p^6 3s^2$ **$3p^6 3d^5 4s^1$**	**1**
5(a)(ii)	(+)3 **and** (+)6	**1**
5(b)(i)	**H** is deep / dark / royal **and** blue (solution) **K** is yellow / yellow-green **M** is blue (precipitate) (allow pink)	**2**
5(b)(ii)	**L** is $[Co(NH_3)_6]^{2+}$ **N** is $[CoCl_4]^{2-}$	**2**
5(b)(iii)	(pale) blue **precipitate**	**1**

Question	Answer	Marks
6(a)(i)	**X** is an ammeter	**1**
6(a)(ii)	**Y** is $AgNO_3$ *or* AgF *or* $AgClO_4$	**1**
6(b)	n(Ag) = 0.500 / 107.9 = $4.6(34) \times 10^{-3}$ n(C) = $0.200 \times 40 \times 60$ = 480 C n(e^-) = $480/1.60 \times 10^{-19}$ = $3(.00) \times 10^{21}$ n(e^-)/n(Ag) = $3.00 \times 10^{21} / 4.634 \times 10^{-3}$ = 6.474×10^{23} (**6.5×10^{23}**)	**3**

Question	Answer	Marks
7(a)(i)	 [1]  + H_2O [1] [1]	3
7(a)(ii)	• *for addition polymerisation*: ΔS will be negative, as many gas molecules are combining to form one (large) molecule • *for condensation polymerisation:* ΔS likely to be positive, (as each pair of monomer molecules join to chain, two molecules of) <u>water</u> forms	2
7(b)(i)	(RCO_2H + H_2NR' ⟶) RCONHR' + H_2O	1
7(b)(ii)	*broken:* C-O, N-H *formed*: C-N, O-H	2
7(b)(iii)	bonds formed: 305 + 460 or 765 bonds broken: 360 + 390 or 750 (both) ΔH = 750 – 765 = **–15** (kJ)	2
7(c)	(If ΔG = 0, then) $\Delta H = T\Delta S$ $\Delta S = \Delta H / T$ = –6000 / 298 = **–20.1 (**J mol^{-1} K^{-1})	2
7(d)(i)	heat with (conc.) $KMnO_4$	1
7(d)(ii)	Sn and HC*l* heat + conc. (then add NaOH)	2

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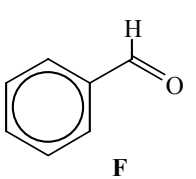
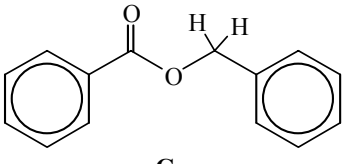
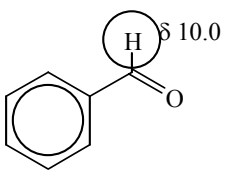
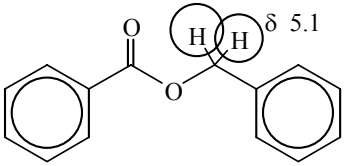
Question	Answer	Marks
7(e)	*intermolecular force* / *group(s) involved* hydrogen bonding / N-H and C=O (of amide) induced dipole / van der Waals / benzene rings	**2**

Question	Answer	Marks
8(a)(i)	7 peaks	**1**
8(a)(ii)	C=O: 1670–1740 OH: 3200–3600 *Or* C-O: 1000–1260	**2**
8(b)(i)	step 1 heat with $AlCl_3$ + $(CH_3)_2CHCl$ *or* $CH_3CH{=}CH_2$ step 2 heat with $AlCl_3$ + CH_3COCl step 3 NaOH + I_2 (*or* Cl_2) (then H^+) step 4 $LiAlH_4$ (in dry ether)	**4**
8(b)(ii)	step 2 electrophilic (aromatic) substitution step 4 reduction	**2**

Question	Answer	Marks
9(a)(i)	n = (100 / 1.1)(8 / 100) = 7.3 ($\Rightarrow$ **7** C atoms)	**1**
9(a)(ii)	$C_7H_7^+$	**1**
9(a)(iii)	**F** is C_7H_6O **G** is $C_{14}H_{12}O_2$	**2**

Question	Answer	Marks
9(a)(iv)	 **F**  **G**	**2**
9(a)(v)	 **F**  **G**	**1**
9(a)(vi)	hydrolysis	**1**
9(b)	benzoic acid > methylphenol > phenylmethanol methylphenoxide anion has delocalisation of the lone pair on oxygen over the ring benzoic acid has an (extra) electronegative oxygen or electron withdrawing C=O	**3**
9(c)	step 1 treat benzoic acid with $SOCl_2$ *or* PCl_5 to make the acyl chloride formula is $\mathbf{C_6H_5COCl}$ step 2 dissolve the methylphenol in NaOH(aq) (and shake with the benzoyl chloride)	**3**

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