Cambridge Assessment International Education
Cambridge International Advanced Subsidiary and Advanced Level

CHEMISTRY **9701/43**

Paper 4 A Level Structured Questions **May/June 2018**

MARK SCHEME

Maximum Mark: 100

Published

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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.

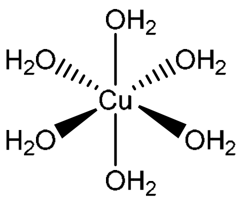
GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely 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)	$4Na(s) + O_2(g) \rightarrow 2Na_2O(s)$	
	balanced with all formulae correct	**1**
	state symbols	**1**
1(b)	giant ionic	**1**
	strong bond / attraction between **AND** positive and negative ions / anions and cations / Na^+ and O^{2-} / oppositely charged ions	**1**
1(c)(i)	the reaction produces sodium hydroxide / hydroxide ions / OH^- ions	**1**
	the hydroxide ions can receive / accept H^+ ions / protons	**1**
1(c)(ii)	Calculation of Na_2O moles 3.10 g / 62 **OR** 0.05	**1**
	Calculation of $[OH^-]$ 0.05 × (2 / 0.400) = 0.25 mol dm^{-3}	**1**
	Calculation of pH –log 0.25 = 0.60 14 – 0.60 = 13.40	**1**
1(d)	use of (2 × 109) or 218 and (2 × 494) or 988	**1**
	use of (0.5 × 496) or 248	**1**
	use of 416, 142, 844	**1**
	evaluation of expression correctly ΔH_{lat} = –416 – (2 × 109) – (0.5 × 496) – (2 × 494) – (–142 + 844) = –2572	**1**
1(e)	the lattice energy of Na_2S is less exothermic	**1**
	the sulfide ion is larger than the oxide ion / S^{2-} larger than O^2 / ionic radii quoted 0.184 nm and 0.140 nm **AND** less attraction (between the ions)/bonds are weaker	**1**

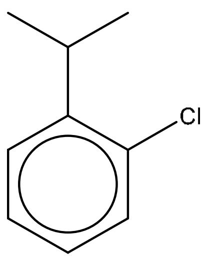
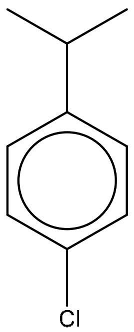
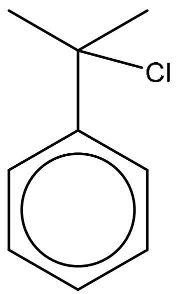
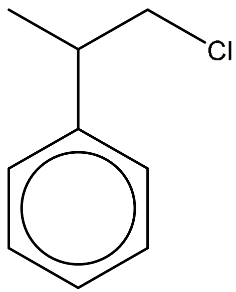
Question	Answer	Marks
2(a)	change in amount / mass / concentration of reactant / product per time	**1**
2(b)	decrease in volume or pressure	**1**
2(c)	8.13×10^4 / 81280 / 81300	**1**
	$mol^{-2}\,dm^6\,s^{-1}$	**1**
2(d)	$\sqrt{(0.00231 / (0.0046 \times 81280))} = 2.49 \times 10^{-3}$	**1**
2(e)	2, 1, 3	**1**
2(f)(i)	2	**1**
2(f)(ii)	the total of steps 1 and 2 / the components of 2 are two NO and one H_2	**1**
2(g)(i)	time for amount or mass or concentration to halve	**1**
2(g)(ii)	0.02 at start and 0.01 after 2 seconds	**1**
	0.005 after 4 seconds and 0.0025 after 6 seconds	**1**
2(h)(i)	$NO + \frac{1}{2}O_2 \rightarrow NO_2$ **or** $NO + O_2 \rightarrow NO_2 + \frac{1}{2}O_2$ **AND** $NO_2 + SO_2 \rightarrow NO + SO_3$	**1**
2(h)(ii)	(NO is) regenerated / reformed	**1**
2(h)(iii)	$SO_3 + H_2O \rightarrow H_2SO_4$ **AND** acid rain or consequence of this described	**1**

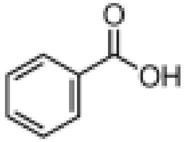
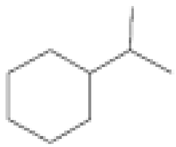
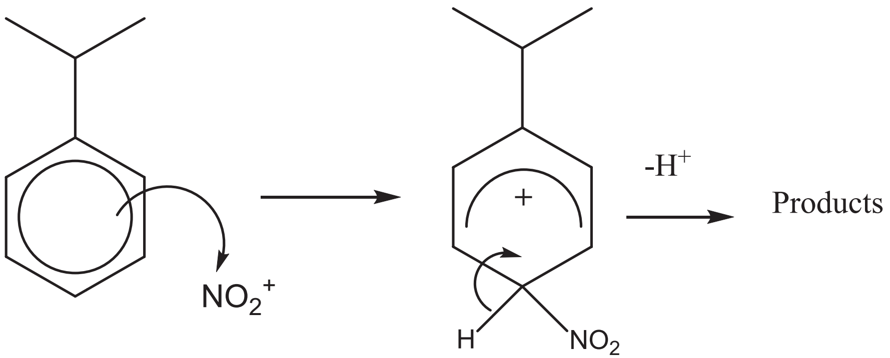
Question	Answer	Marks
3(a)	<table><tr><th></th><th>anode</th><th>cathode</th></tr><tr><td>$AgNO_3$ (aq)</td><td>**oxygen / O_2**</td><td>**silver / Ag**</td></tr><tr><td>saturated $NaCl$ (aq)</td><td>**chlorine / Cl_2**</td><td>**hydrogen / H_2**</td></tr><tr><td>$CuSO_4$ (aq)</td><td>**oxygen / O_2**</td><td>**copper / Cu**</td></tr></table>	**3**
3(b)(i)	$2I^- \rightarrow I_2 + 2e^-$	**1**
	$Ca^{2+} + 2e^- \rightarrow Ca$	**1**
3(b)(ii)	• Ca / Calcium reduced and I / iodine oxidised • Oxidation number of calcium decreases from 2 to 0 • Oxidation number of iodine increases from –1 to 0 2 points = 1 mark 3 points = 2 marks	**2**
3(b)(iii)	• metal / grey / silvery • purple AND vapour / gas / fumes • amount of melt decreases any 2 points for 1 mark	**1**
3(c)	$2 \times 60 \times 60 \times 0.8 = 5760$ C **AND** 5760 / 96500 = 0.060 (0.0597) F	**1**
	1.11 / 55.8 = 0.020 (0.0199) mol of Fe	**1**
	0.06 / 0.02 = 3 ∴ Fe^{3+} or +3 or 3	**1**

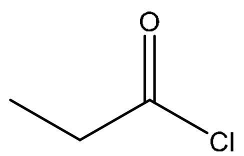
Question	Answer	Marks
4(a)	calcium – red flame	**1**
	barium – green flame	**1**
4(b)	• the temperature increases down the group • ionic radius increases / charge density decreases down the group • decreasing distortion / polarisation **or** decreasing weakening of bonds • of the anion / the CO_3^{2-} ion 2 points = 1 mark 3 points = 2 marks 4 points = 3 marks	**3**
4(c)	the gas is colourless / looks like air / cannot be seen	**1**
	appearance of solid doesn't change / white solid becomes white solid	**1**

Question	Answer	Marks
5(a)	$3s^2 3p^6 3d^{10} 4s^1$	**1**
	$3s^2 3p^6 3d^{10}$	**1**
5(b)	Cl-Cu-Cl	**1**
	one minus charge	**1**
5(c)		**1**
	octahedral **and** 90° or 180° labelled correctly on diagram as appropriate	**1**

Question	Answer	Marks
5(d)	reaction 1: blue ppt / blue **solid**	**1**
	$[Cu(H_2O)_6]^{2+} + 2OH^- \rightarrow Cu(OH)_2 + 6H_2O$ or $[Cu(H_2O)_6]^{2+} + 2OH^- \rightarrow Cu(OH)_2(H_2O)_4 + 2H_2O$ or $[Cu(H_2O)_6]^{2+} + 2NH_3 \rightarrow Cu(OH)_2(H_2O)_4 + 2NH_4^+$	**1**
	reaction 2: deep / dark / royal blue solution	**1**
	$Cu(OH)_2 + 4NH_3 + 2H_2O \rightarrow [Cu(NH_3)_4(H_2O)_2]^{2+} + 2OH^-$ or $Cu(OH)_2 + 4NH_3 \rightarrow [Cu(NH_3)_4]^{2+} + 2OH^-$ or $Cu(OH)_2(H_2O)_4 + 4NH_3 \rightarrow [Cu(NH_3)_4(H_2O)_2]^{2+} + 2OH^- + 2H_2O$	**1**
5(e)(i)	ligand exchange / displacement / replacement / substitution	**1**
5(e)(ii)	K_{stab} =[$[CuEDTA]^{2-}$] / [$[Cu(H_2O)_6]^{2+}$][$[EDTA]^{4-}$]	**1**
5(e)(iii)	stable / more stable than $[Cu(H_2O)_6]^{2+}$	**1**
5(f)(i)	donates lone pairs / forms dative / co-ordinate bonds to (central) metal atom / metal ion	**1**
	donates two lone pairs / forms two (dative or coordinate) bonds	**1**
5(f)(ii)	$[Zr(C_2O_4)_4]^{4-}$	**1**
	not octahedral because 8 dative bonds to Zr **or** not octahedral because not 6 dative bonds to Zr **or** not octahedral because co-ordination number is 8 / is not 6	**1**

Question	Answer	Marks
6(a)(i)	**D** 2-chloropropane	**1**
	E hydrogen chloride	**1**
6(a)(ii)	(Friedel-Crafts) alkylation	**1**
6(b)(i)	$AlCl_3$ or $FeCl_3$	**1**
6(b)(ii)	 	**1**
6(b)(iii)	sunlight or UV **OR** T>100 °C	**1**
6(b)(iv)	 	**1**

Question	Answer	Marks
6(c)	reaction with hot $KMnO_4(aq)$ 	**1**
	reaction with H_2 + Ni, high pressure 	**1**
6(d)	 	
	attacking species is NO_2^+	**1**
	curly arrow starting within hexagon and going to NO_2^+	**1**
	correct intermediate	**1**
	2nd curly arrow from C-H bond into ring	**1**

Question	Answer	Marks
7(a)	$2C_3H_7OH + 2Na \rightarrow 2C_3H_7ONa + H_2$	**1**
7(b)(i)	propanoic acid, phenol, propan-1-ol	**1**
7(b)(ii)	• propan-1-ol: O-H bond strengthened by positive inductive effect of alkyl group **OR** propoxide ion is destabilised by positive inductive effect of alkyl group • phenol: O-H bond weakened by negative inductive effect of ring **OR** phenoxide ion is stabilised by delocalisation of oxygen lone pair into ring • propanoic acid: O-H bond weakened by negative inductive effect of C=O **OR** propanoate ion is stabilised by delocalisation of minus charge by C=O 1 mark for a correct explanation, max 2 marks	**2**
7(c)	Tollens' reagent **or** Fehling's reagent	**1**
	methanoic acid gives a silver mirror/solid with Tollen's reagent **OR** red / orange ppt / solid with Fehlings' reagent	**1**
7(d)	PCl_5 or PCl_3 (+heat) or $SOCl_2$ (added to propanoic acid)	**1**
	product of first step: 	**1**
	add product of first step to phenol in NaOH	**1**
7(e)(i)	propanoic acid	**1**
7(e)(ii)	propan-1-ol would have peak at 0.5–6.0 because of OH group	**1**
	propanal would have peak at 9.3–10.5 because of CHO / aldehyde	**1**

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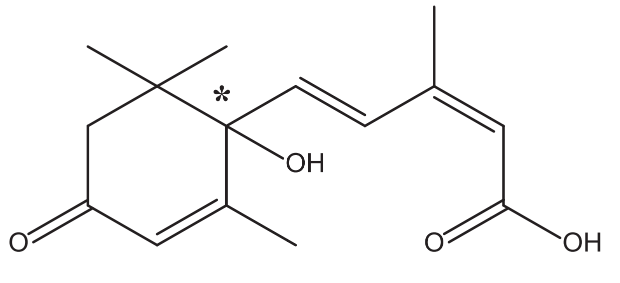
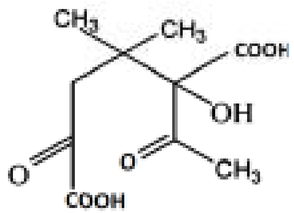
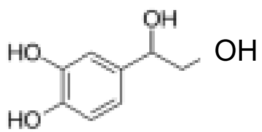
Question	Answer	Marks
8(a)	correct chiral centre labelled **only**  $C_{15}H_{22}O_4$	1
8(b)	$C_{15}H_{22}O_4$	1
8(c)(i)		1
8(c)(ii)	CO_2	1
	oxidation / oxidative cleavage	1
8(c)(iii)	CH_3COCO_2H	1

Question	Answer	Marks
9(a)	$C_8H_{11}O_3N$	**1**
9(b)	yes, as it has a chiral C atom	**1**
9(c)(i)	(phenyldiazonium ion is stabilised because) positive charge is delocalised by ring / positive charge is spread over ring	**1**
9(c)(ii)		**1**
	N_2	**1**