Cambridge International AS & A Level

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CHEMISTRY **9701/42**

Paper 4 A Level Structured Questions **May/June 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)	simple molecular / simple covalent	**1**
	weak London forces / id-id forces / VDW forces ***or*** London forces / id-id forces / VDW forces **AND** small amount of energy to break	**1**
1(b)(i)	$SiCl_4 + 2H_2O \rightarrow SiO_2 + 4HCl$ or $SiCl_4 + 4H_2O \rightarrow Si(OH)_4 + 4HCl$	**1**
1(b)(ii)	white solid	**1**
	steamy fumes / white fumes / misty fumes	**1**
1(b)(iii)	moles of $SiCl_4$ = 0.8505 / 170.1 = 0.005	**1**
	conc of H^+ (0.005) $\times$ 4 / 0.8 = 0.025	**1**
	pH = –log(0.025) = 1.6	**1**
1(c)(i)	–225.7 = 239.0 – (18.7 + 2x)	**1**
	x = +223	**1**
1(c)(ii)	decrease in number of **moles** of **gas** /more **moles** of **gas** on left / reactants (ora)	**1**
1(d)	use of $\Delta G = \Delta H - T\Delta S$ with $\Delta G = 0$ / $\Delta G > 0$ **or** $T = \Delta H / \Delta S$ or T = (640 000 / 225.7)	**1**
	2836 / 2840 (2835.6)	**1**

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Question	Answer	Marks
2(a)	colorimetry / (change) in colour / less light transmission / measure absorbance	**1**
2(b)	Exp 1 and 2: rate × 1.75 and $[H_2]$ × 1.75 (when [IC*l*] no change) **or** calculation e.g.: order = (0.007 / 0.004) / (1.75 / 1.00) = 1 **or** Exp 1 and 3: rate × 2.5 and $[H_2]$ × 2.5 (when [IC*l*] no change) **or** Exp 2 and 3: rate × 10 / 7(1.43) and $[H_2]$ × 10 / 7(1.43) (when [IC*l*] no change)	**1**
2(c)	Exp 4 and 5: rate × 1.4 and [IC*l*] × 1.4 (when $[H_2]$ no change) **or** calculation	**1**
2(d)	(rate=) k[IC*l*]$[H_2]$	**1**
2(e)	62 500 **or** 6.25×10^4	**1**
2(f)	IC*l* + H_2 → HC*l* + HI **or** IC*l* + H_2 → IC*l*H_2 **or** IC*l* + H_2 → ½I_2 + C*l*H_2	**1**
	HI + IC*l* → HC*l* + I_2 **or** IC*l*H_2 + IC*l* → 2HC*l* + I_2 **or** C*l*H_2 + IC*l* → 2HC*l* + ½I_2	**1**

Question	Answer	Marks
2(g)(i)	part mark 1: plot a graph of concentration of $[H_2]$ against time part mark 2: constant half-life (showing it is 1st order) part mark 3: draw tangent **AND** determine gradient (on conc vs time graph) **or** draw two tangents to determine two gradients (rate) (on conc vs time graph) part mark 4: if conc 1 (at time 1) / conc 2 (at time 2) = gradient 1 / gradient 2 part mark 5: plot a graph of rate against concentration of $[H_2]$ part mark 6: gives a straight-line through the origin of graph for part mark 5 2 parts = 1 mark 3 parts = 2 marks 4 parts = 3 marks	**3**
2(g)(ii)	[IC*l*] doesn't change ***or*** [IC*l*] only changes slightly	**1**
2(h)	provides an alternative route of lower activation energy / E_a **or** to lower E_a and more molecules with $E \geqslant E_a$	**1**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>3(a)</td><td>
<table>
<tr><td></td><td>anode</td><td>cathode</td></tr>
<tr><td>NaOH (aq)</td><td>oxygen / O_2</td><td>hydrogen / H_2</td></tr>
<tr><td>dilute $CuCl_2$ (aq)</td><td>oxygen / O_2</td><td>copper / Cu</td></tr>
<tr><td>conc $MgCl_2$ (aq)</td><td>chlorine / Cl_2</td><td>hydrogen / H_2</td></tr>
</table>
</td><td>3</td></tr>
<tr><td rowspan="3">3(b)(i)</td><td>$2Br^- \rightarrow Br_2 + 2e^-$ or $2Br^- - 2e^- \rightarrow Br_2$</td><td>1</td></tr>
<tr><td>$Zn^{2+} + 2e^- \rightarrow Zn$</td><td>1</td></tr>
<tr><td>Zinc / Zn^{2+} reduced and Br^- / bromide oxidised</td><td>1</td></tr>
<tr><td>3(b)(ii)</td><td>liquid / molten metal
or orange-<u>brown</u> / reddish <u>brown</u> vapour / gas (at anode)
or amount of melt / electrolyte decreases</td><td>1</td></tr>
<tr><td>3(c)</td><td>• $50 \times 60 \times 1.2$ or 3600 C (calculation of number of Coulombs)
• 3600 / 96 500 or 0.0373 F (calculation of number of Faradays)
• 0.0373 F / 2 or 0.01865 / 0.0187 mol H_2 (use of stoichiometry)
• $0.01865 \times 24\,000$ = 448–449 (Use of 24 000 & answer to 3sf)
2 points = 1 mark
3 points = 2 marks
4 points = 3 marks</td><td>3</td></tr>
</table>

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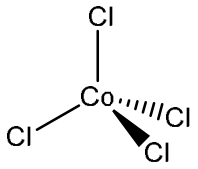
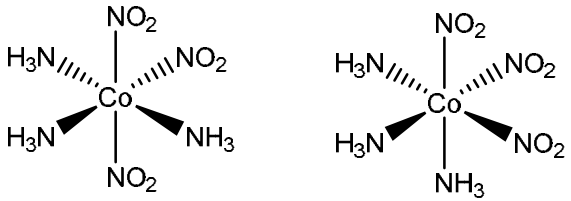
Question	Answer	Marks
4(a)(i)	$2Ca(NO_3)_2 \rightarrow 2CaO + 4NO_2 + O_2$	**1**
	correct state symbols: (s), (s), (g), (g)	**1**
4(a)(ii)	**brown** gas / fumes / vapour	**1**
	white solid / residue (stays the same)	**1**
4(b)	solubility **decreases** (down the group)	**1**
	ΔH_{latt} and ΔH_{hyd} decrease / both become less exothermic / less negative	**1**
	$\boldsymbol{\Delta H_{latt}}$ decreases / becomes less exothermic by a smaller extent **ora**	**1**
	ΔH_{sol} becomes less exothermic / less negative **ora**	**1**

Question	Answer	Marks
5(a)	$3s^2 3p^6 3d^7 4s^2$ **or** $3s^2 3p^6 4s^2 3d^7$	**1**
	$3s^2 3p^6 3d^7$	**1**
5(b)(i)	An ion formed by a central metal atom / ion surrounded by / bonded to (one or more) ligand(s)	**1**
5(b)(ii)	charge is 2–	**1**
		**1**

Question	Answer	Marks
5(b)(iii)	d-orbitals are split into two groups of orbitals	**1**
	absorption of light	**1**
	an electron is excited / (during) electron promotion (to a higher d-orbital)	**1**
5(b)(iv)	blue light is not absorbed **or** absorb (wavelength / frequency of) red and yellow / orange / green **or** absorbs least in the blue region	**1**
5(c)	(blue goes) pink	**1**
	ligand exchange / ligand substitution	**1**
5(d)(i)	F_2 or $S_2O_8^{2-}$	**1**
5(d)(ii)	+1.05 or +0.19	**1**
5(d)(iii)	$2Co^{2+} + F_2 \rightarrow 2Co^{3+} + 2F^-$ **or** $2Co^{2+} + S_2O_8^{2-} \rightarrow 2Co^{3+} + 2SO_4^{2-}$	**1**
5(e)	 trans 3D diagram – two O_2N-Co-NO_2 bond angles are 90° and the other is 180°	**1**
	cis 3D diagram – three O_2N-Co-NO_2 bond angles are 90° to each other	**1**
	cis-trans / geometric(al)	**1**

Question	Answer	Marks
6(a)	<u>any two from</u> K / potassium or KOH / potassium hydroxide or K_2O / potassium oxide	**2**
	correct products: (K) hydrogen, (KOH) water, (K_2O) water	**1**
6(b)(i)	bond circled between N = N	**1**
6(b)(ii)	phenylamine **and** HNO_2	**1**
	T=10 ^oC or below **and** diazonium ion / salt formed or structure of diazonium ion as $[C_6H_5N_2^+]$	**1**
	add 2-naphthol in aqueous NaOH / alkali	**1**
6(c)(i)	dilute / aqueous nitric acid / $HNO_3(aq)$ (at room temp.)	**1**
	<u>any two from</u> concentrated (acid) needed sulfuric acid / H_2SO_4 needed higher T needed **ora**	**1**
6(c)(ii)	p-orbital(s) / lone pair on oxygen / OH group delocalises into / over ring	**1**

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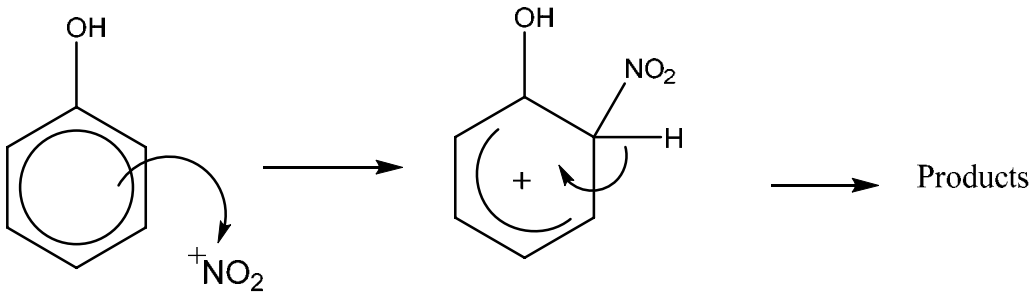
Question	Answer	Marks
6(c)(iii)		
	first curly arrow	**1**
	structure of intermediate	**1**
	2nd curly arrow	**1**
6(c)(iv)	4-nitrophenol	**1**

Question	Answer	Marks
7(a)	$C_4H_8N_2O_3$	**1**
7(b)	amide, amine, carboxylic acid 2 correct = 1 mark 3 correct = 2 marks	**2**

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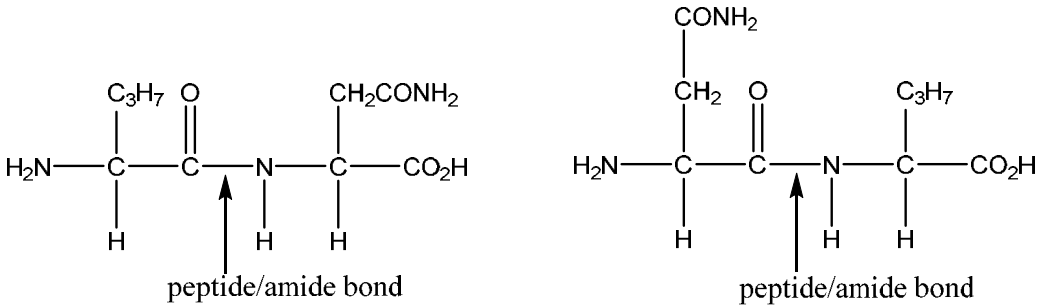
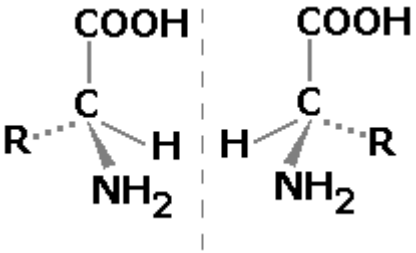
Question	Answer	Marks
7(c)		
	peptide / amide bond / unit labelled or circled	**1**
	(val-asp or asp-val) rest of the dipeptide structure is correct	**1**
7(d)(i)	resists change in pH / pH kept within a small range	**1**
	when small amount of acid or alkali / base is added	**1**
7(d)(ii)	$H_2NCHRCO_2H + H^+ \rightarrow H_3N^+CHRCO_2H$	**1**
	$H_2NCHRCO_2H + OH^- \rightarrow H_2NCHRCO_2^- + H_2O$	**1**
7(e)	 each structure [1]	**2**

Question	Answer	Marks
7(f)	$H_2NCH(CH_2CONH_2)CO_2H + H_2O \rightarrow H_2NCH(CH_2CO_2H)CO_2H + NH_3$ scores **or** $H_2NCH(CH_2CONH_2)CO_2H + H_2O + 2H^+ \rightarrow H_3N^+CH(CH_2CO_2H)CO_2H + NH_4^+$	**2**

Question	Answer	Marks
8(a)	0, 2, 1	**1**
8(b)	6	**1**
8(c)	4	**1**
8(d)(i)	4	**1**
8(d)(ii)	range δ 25–5	**1**
	range δ 190–220	**1**
	one peak in first range and three peaks in second range	**1**
8(d)(iii)	1	**1**
8(d)(iv)	singlet	**1**
	neighbouring / adjacent (carbon) atom has no protons / H	**1**
8(e)(i)	CO_2	**1**
	(further) oxidation / oxidative cleavage	**1**

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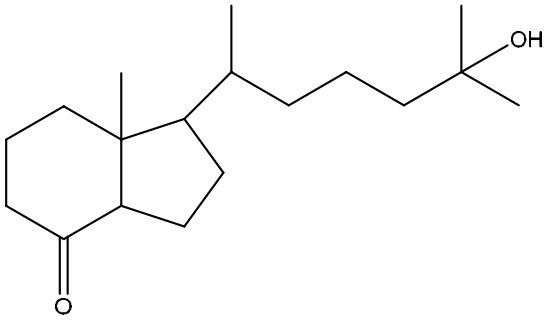
Question	Answer	Marks
8(e)(ii)		**1**

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