Mock Exam 1

CHEMISTRY 9701

Paper 4 A Level Structured Questions

MARK SCHEME

Maximum Mark: 110

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 acceptabilit y of alternative answers.

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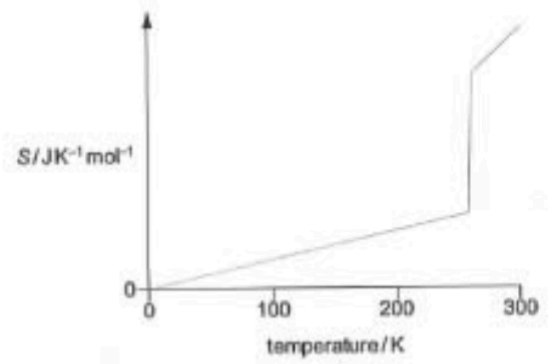
Q1.

Question	Answer	Marks
3(a)(i)	(+193 + 242 + 590 + 1150 + (2 × –349)) [1] answer (+)1477 [1]	**2**
3(a)(ii)	(–795 – 83 – 1477) [1] –2355 [1]	**2**
3(a)(iii)	(–2355 –(2 × –364)) [1] –1627 [1]	**2**
3(a)(iv)	Z–Y or X–W [1]	**1**
3(a)(v)	less (exothermic) and both ions (in $CaCl_2$) are larger [1]	1
3(b)(i)	soluble barium salt **AND** soluble sulfate [1]	1
3(b)(ii)	less soluble (down the group) [1] ΔH_{lat} and ΔH_{hyd} both decrease down the group [1] ΔH_{hyd} decreases more / faster / is dominant factor [1] ΔH_{sol} gets less exo / more endo [1]	**4**

c



M1 continuous increase in *S* from 0–300 K (excluding m.p.) [1]
M2 steep vertical increase in *S* **ONLY** at the m.p. **AND** continuous increase in *S* after m.p. [1]

2

d

[1] for each correct tick

	negative $\Delta S^{\ominus}$	positive $\Delta S^{\ominus}$
solid dissolving in water		✓
water boiling to steam		✓

1

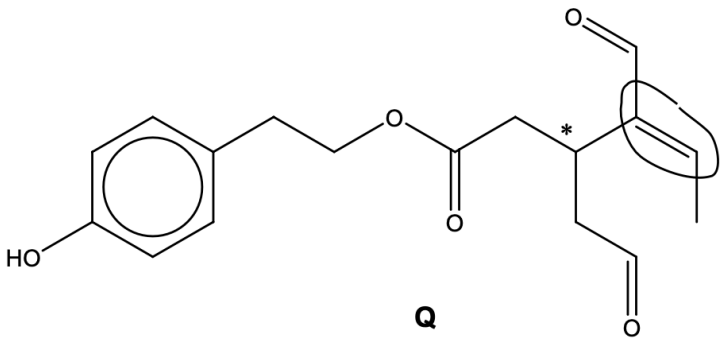
e

$\Delta H^{\ominus}$ = (2 × C=O) + (3 × H-H) – (3 × C-H) – (C-O) – (3xO-H)
$\Delta H^{\ominus}$ = (2 × 805) + (3 × 436) – (3 × 410)– (1 × 360) – (3 × 460) [1]
$\Delta H^{\ominus}$ = 1610 + 1308 – 1230 – 360 – 1380 = **– 52** (kJ mol^{-1}) [1] ecf correct answer scores [2]

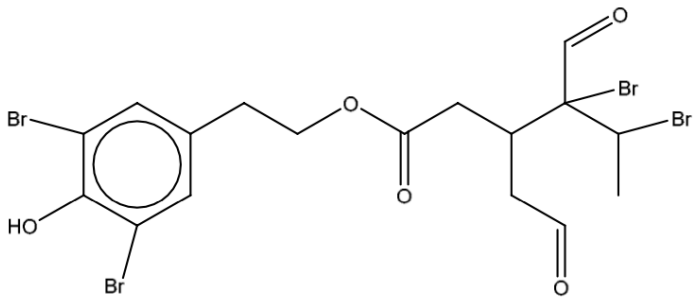
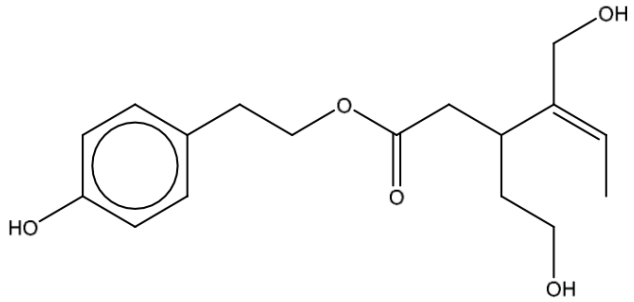
2

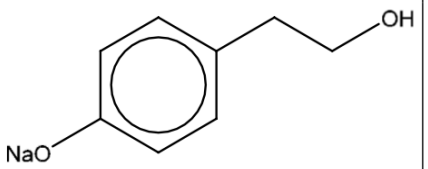
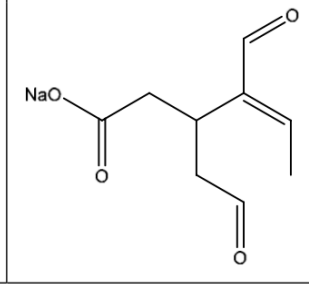
2

Question	Answer	Mark
(a)	<table><tr><td></td><td colspan="2">identity or value</td></tr><tr><td>**V**</td><td>nitrogen or</td><td>chlorine</td></tr><tr><td>**X**</td><td>NO/NO_2</td><td>ClO_2/ClO_3</td></tr><tr><td>**m**</td><td>2, 3</td><td>1,2,3, or 4</td></tr><tr><td>**W**</td><td colspan="2">sulfur</td></tr><tr><td>**Y**</td><td colspan="2">SO_2 or SO_3</td></tr><tr><td>**n**</td><td colspan="2">4, 3</td></tr></table>	3
(b)	**M1**: (white precipitate is $BaSO_4$) descending the group ΔH_{sol} becomes more endothermic / positive; **M2, M3** any **two** from: ΔH_{latt} decreases / becomes more endothermic / becomes less exothermic ΔH_{hyd} decreases / becomes more endothermic / becomes less exothermic ΔH_{hyd} decreases more than ΔH_{latt}	1 2

3	6(a)	 **Q**	**1**
	6(b)(i)	**ratio** of the **concentration** of a solute in the (two immiscible) solvents / liquids at equilibrium	1 1 **2**
	6(b)(ii)	$K_{partition}$ = (0.06 / 40) / (0.25–0.06 / 10) or reversed ratio: $K_{partition}$ = (0.25–0.06 / 10) / (0.06 / 40) $K_{partition}$ = **0.079** (0.0789) $K_{partition}$ = 12.7/13.0	1 1 **2**

3c (c)

reagent	structure of product(s)	type of reaction	
excess $Br_2(aq)$	 addition of bromine to alkene 2×Br substituted in phenol at positions **2** and **6**	(electrophilic) substitution or (electrophilic) addition	1 1
$NaBH_4$		reduction (**allow** nucleophilic addition)	1

	excess hot NaOH(aq)   hydrolysis all three reaction types	1+1 1 **6**

(d)	mixture of (two) **optical / stereo** isomer**s** formed	1 **1**
	Total:	**12**

4a	(an element) forming one or more (stable) **ions** or **compounds** or **oxidation states** with **partially filled / incomplete d orbitals**	1 **1**

b

(b)(i)	**A** $Co(OH)_2$ **OR** $Co(H_2O)_4(OH)_2$ **B** $[CoCl_4]^{2-}$ **C** $[Co(NH_3)_6]^{2+}$ **OR** $[Co(NH_3)_6]^{3+}$ two correct = 1 mark three correct = 2 marks	**2**
(b)(ii)	$[Co(H_2O)_6]^{2+}$ pink solution of **B** blue solution of **C** brown/yellow/orange	

two correct = 1 mark three correct = 2 marks	**2**

c

(i)	*K*stab = $[(Cu(NH_3)_4)^{2+}] / [(Cu(H_2O)_6)^{2+}] [NH_3]^4$ [1]	**1**
(ii)	**deep / dark / royal** blue [1]	**1**

d

$[Cu(NH_3)_4]^{2+} + 2H_2O \rightarrow Cu(OH)_2 + 2NH_4^+ + 2NH_3$ [1]
OR $[Cu(NH_3)_4]^{2+} + 2H_2O \rightarrow Cu(OH)_2 + 2H^+ + 4NH_3$

1

e

$Cu(OH)_2 + 4HCl \rightarrow [CuCl_4]^{2-} + 2H_2O + 2H^+$
OR $Cu(OH)_2 + 4Cl^- + 2H^+ \rightarrow [CuCl_4]^{2-} + 2H_2O$

$[CuCl_4]^{2-}$ complex including charge [1]
rest of equation fully correct [1]

2

f

	Y	Z
colour of complex	yellow	blue / pale blue
geometry of complex	tetrahedral	octahedral
formula of complex		$[Cu(H_2O)_6]^{2+}$

one mark for any **three** cells [1] • • ✓
two marks for all five cells [2] • • ✓ • ✓

2

g

(i)	Circles round both N atoms and all four O^-	**1**
(ii)	**M1:** (d–d) energy gap / ΔE is different **M2:** different frequency / wavelength (of light) absorbed	**2**
(iii)	ligand exchange / substitution / displacement / replacement	**1**

5	(a)	colorimetry / (change) in colour / less light transmission / measure absorbance	**1**
	(b)	Exp 1 and 2: rate × 1.75 and $[H_2]$ × 1.75 (when $[ICl]$ 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 $[ICl]$ no change) **or** Exp 2 and 3: rate × 10 / 7(1.43) and $[H_2]$ × 10 / 7(1.43) (when $[ICl]$ no change)	**1**
	(c)	Exp 4 and 5: rate × 1.4 and $[ICl]$ × 1.4 (when $[H_2]$ no change) **or** calculation	**1**
	(d)	(rate=) $k[ICl][H_2]$	**1**
	(e)	62 500 **or** 6.25×10^4	**1**
	(f)	$ICl + H_2 \rightarrow HCl + HI$ **or** $ICl + H_2 \rightarrow IClH_2$ **or** $ICl + H_2 \rightarrow ½I_2 + ClH_2$	**1**
		$HI + ICl \rightarrow HCl + I_2$ **or** $IClH_2 + ICl \rightarrow 2HCl + I_2$ **or** $ClH_2 + ICl \rightarrow 2HCl + ½I_2$	**1**

(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**
(g)(ii)	[ICl] doesn't change ***or*** [ICl] only changes slightly	**1**

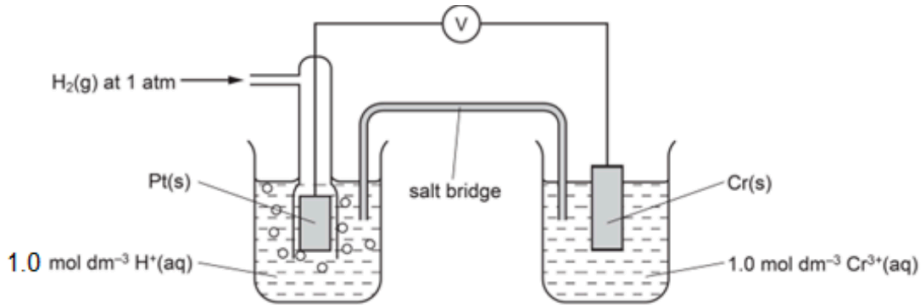
(h)	provides an alternative route of lower activation energy / E_a **or** to lower E_a and more molecules with $E \geqslant E_a$	**1**

6

(a)(i)	10	**1**
(a)(ii)	120	**1**
(b)(i)	correct acid chloride	**1**
(b)(ii)	NH_3 or ammonia	**1**

(c)	**M1:** $(C_5NH_4)COOH$ or $(C_5NH_5)^+COOH$ **M2:** $(C_5NH_4)COO^-(Na^+)$ or $(C_5NH_4)COONa$	**2**

(d)(i)	$LiAlH_4$	**1**
(d)(ii)	**M1:** most basic: X > phenylamine > nicotinamide :least basic **M2:** LP in X cannot be delocalised **M3:** LP in phenylamine <u>delocalised</u> over the benzene ring **or** LP in amide <u>delocalised</u> (more effectively) by C=O	**3**
(e)	**M1:** M + 1 / M = (1.1 × ?) / 100 **M2:** Ans 5.28 Award 2 marks for correct answer	**2**

7 **a**		H_3PO_2	1	1	
b	**i**	the electrode potential *E* would become **more positive** / **less negative** than $E^{\ominus}$ lower $[H_2PO_2^-]$ shifts equilibrium to the right hand side	1 1	2	**ALLOW** use of Nernst M1 equation M2 –1.53 V
b	**ii**	+1.57 – 0.74 = (+)**0.83** (V)	1	1	
b	**iii**	 • Pt(s) • Cr(s) • H^+(aq) • Cr^{3+}(aq) • H_2(g) • voltmeter • salt bridge • conditions of 1 atm **AND** 1 mol dm^{-3} • other liquid level and wire to electrode	3	3	●●✔●●✔●●✔ state symbols not required
b	**iv**	Pt electrode positive **AND** flow of electrons anticlockwise (to the SHE)	1	1	LINK to 2b(iii)

b	**v**	$H_2PO_2^- + 3OH^- + Ni^{2+} \rightarrow HPO_3^{2-} + 2H_2O + Ni$	1	1	**any multiple**

8a

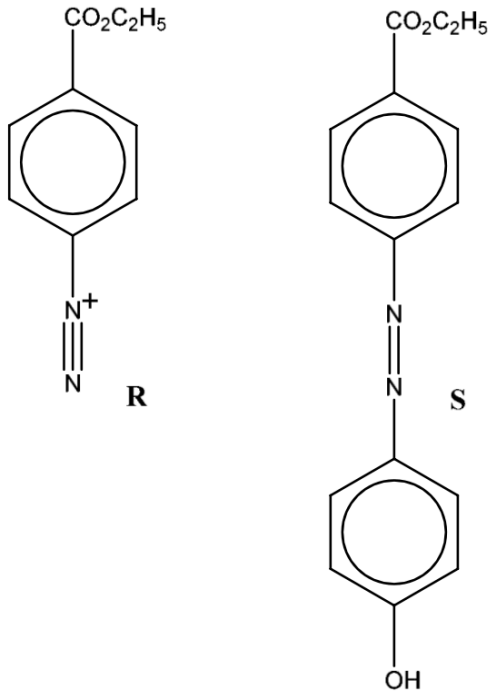
)(i)	4-aminobenzoic acid	**1**
(ii)	step 1 Sn + HC*l* [1] concentrated / reflux / heat [1] step 2 CH_3COCl [1] step 3 $KMnO_4$ / manganate(VII) / MnO_4^- (acidified / alkaline) **and** heat [1] step 4 aqueous HC*l* **and** heat [1] step 5 ethanol, H_2SO_4, concentrated / reflux / heat [1]	**6**

b

(benzocaine) is less (basic than ethylamine) **AND** **lone pair** (on N) is less available to **accept** a proton / H^+ since (lone pair on N) is delocalised over the ring ***or*** phenyl ring is electron withdrawing group **OR** ethylamine is more basic (than benzocaine) **AND** **lone pair** (on N) is more available to **accept** a proton / H^+ since ethyl / alkyl group is electron-donating group	**2**

c

)(i)	7 peaks	**1**
)(ii)	$CDCl_3$ will produce no signal in the spectrum **or** $CHCl_3$ would produce a signal / would be detected	**1**
(iii)	<table><tr><th>*δ/ppm*</th><th>group responsible for the peak</th><th>number of H atoms responsible for the peak</th><th>splitting pattern</th></tr><tr><td>*1.2*</td><td>$CH_{(3)}$</td><td>3</td><td>triplet</td></tr><tr><td>*3.5*</td><td>$CH_{(2)}O$</td><td>2</td><td>quartet</td></tr><tr><td>*5.5*</td><td>NH_2</td><td>2</td><td>singlet (broad)</td></tr><tr><td>*7.1–7.4*</td><td>H attached to aromatic / benzene ring</td><td>4</td><td>*multiplet*</td></tr></table>	**4**
(iv)	neighbouring / adjacent carbon **atom** has two protons / H (attached to it) **or** there is an adjacent $CH_2(O)$ group	**1**
)(v)	peak at 5.5 / NH_2 peak will disappear **and** NH_2 / protons exchange / swap with deuterium	**1**

d	(i)	$NaNO_2 + HCl$ ***or*** HNO_2	**1**
	(ii)		
		structure of diazonium salt **R**	**1**
		structure of azo dye **S**	**1**