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**CHEMISTRY**

**9701/41**

Paper 4 A Level Structured Questions

**May/June 2016**

MARK SCHEME

Maximum Mark: 100

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**Published**

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<b>Question</b>	<b>Answer</b>	<b>Marks</b>
<b>1 (a) (i)</b>	$\text{Ca(OH)}_2 + \text{CO}_2 \longrightarrow \text{CaCO}_3 + \text{H}_2\text{O}$	[1]
<b>(ii)</b>	$\text{Ba(OH)}_2$ is soluble, OR $\text{BaCO}_3$ is insoluble	[1]
<b>(iii)</b>	$\text{Mg(OH)}_2$ is insoluble / not very soluble will not form ppt. of $\text{MgCO}_3$	[1] [1]
<b>(b)</b>	carbonates are more stable down the group due to increase in cationic size / radius (causing) less polarisation of $\text{CO}_3^{2-}$ ion	[1] [1] [1]
<b>(c)</b>	radius of $\text{Ni}^{2+} = 0.070 \text{ nm}$ ; radius of $\text{Ca}^{2+} = 0.099 \text{ nm}$ so $\text{NiCO}_3$ decomposes more readily than $\text{CaCO}_3$	[1] [1]
		<b>[Total: 9]</b>
<b>2 (a) (i)</b>	Co: ... $3s^23p^63d^74s^2$ Co <sup>2+</sup> : ... $3s^23p^63d^7$	[1]
<b>(ii)</b>	solution starts pink turns blue pink is $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$ blue is $[\text{CoC}_4]^{2-}$ this complex is tetrahedral	[1] [1] [1] [1] [1]

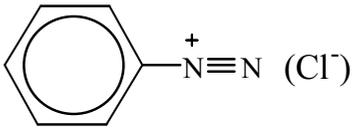
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Question	Answer	Marks
(b)		[1] [1] [1]
		<b>[Total: 9]</b>
3 (a)	$K_p = \frac{\{p(\text{CS}_2) \times (p(\text{H}_2))^4\}}{\{(p(\text{H}_2\text{S}))^2 \times p(\text{CH}_4)\}}$ units: $\text{atm}^2$ OR $\text{Pa}^2$	[1] [1]
(b) (i)	$p(\text{H}_2\text{S}) = 196 \text{ atm}$ $p(\text{H}_2) = 8 \text{ atm}$	[1] [1]
(ii)	$K_p = \frac{(2 \times 8^4)}{(196^2 \times 98)} = 2.176 \times 10^{-3}$	[1]
(c) (i)	$\Delta S^\ominus$ will be positive, because more gas moles on the RHS/products	[1]
(ii)	$\Delta S^\ominus = \frac{(\Delta H^\ominus - \Delta G^\ominus)}{T} = \frac{(241 - 51)}{1000} = 0.19 \text{ OR } 190$ $\text{kJ mol}^{-1} \text{K}^{-1}$ OR $\text{J mol}^{-1} \text{K}^{-1}$	[1] [1]
(d)	$\Delta G^\ominus$ will become less positive/more negative as $T$ increases, ...because $\Delta S^\ominus$ is positive (or $-T\Delta S^\ominus$ is more negative) ...therefore the reaction becomes more feasible/spontaneous as $T$ increases	[2]
		<b>[Total: 10]</b>

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<b>Question</b>	<b>Answer</b>	<b>Marks</b>
<b>4 (a) (i)</b>	SCP is the EMF / potential of a cell composed of two electrodes (OR half cells) under standard conditions (OR at 289 K OR 1 mol dm <sup>-3</sup> )	[1]
<b>(ii)</b>	voltmeter and salt bridge	[1]
<b>(iii)</b>	<b>A</b> is Ag <b>B</b> is Ag <sup>+</sup> (aq) or AgNO <sub>3</sub> (aq) <b>C</b> is Pt <b>D</b> is Fe <sup>2+</sup> (aq) and Fe <sup>3+</sup> (aq)  (combination of <b>A</b> and <b>B</b> can be reversed with combination of <b>C</b> and <b>D</b> )	[3]
<b>(b) (i)</b>	Ag <sup>+</sup> + Fe <sup>2+</sup> → Ag + Fe <sup>3+</sup>	[1]
<b>(ii)</b>	$E = E^{\ominus} + 0.059 \log [\text{Ag}^+] = 0.80 - 0.03 = 0.77 \text{ V}$ so $E_{\text{cell}} = 0.77 - 0.77 = 0.0 \text{ V}$	[1] [1]
		<b>[Total: 8]</b>
<b>5 (a) (i)</b>	pK <sub>a</sub> = -log K <sub>a</sub>	[1]
<b>(ii)</b>	diacids are more acidic than CH <sub>3</sub> CO <sub>2</sub> H HO <sub>2</sub> C- group is electron-withdrawing, stabilising the monoanion OR HO <sub>2</sub> C- group is electron-withdrawing, weakening the O-H bond OR monoanion is stabilised by H-bonding as n increases, the electron-withdrawing group is further away from the ionising CO <sub>2</sub> H group OR the (intervening) alkyl groups destabilise the anion	[1] [1] [1]
<b>(iii)</b>	removing H <sup>+</sup> from an anion is not electrostatically favourable	[1]
<b>(b) (i)</b>	a solution which <i>resists</i> changes in pH when <i>small</i> amounts of H <sup>+</sup> or OH <sup>-</sup> are added	[1] [1]

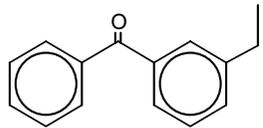
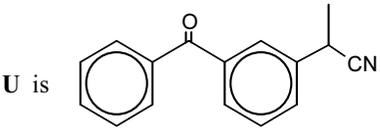
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Question	Answer	Marks
(ii)	$\text{HO}_2\text{CCH}_2\text{CH}_2\text{CO}_2\text{Na} + \text{H}^+ \rightarrow \text{HO}_2\text{CCH}_2\text{CH}_2\text{CO}_2\text{H} + \text{Na}^+$ $\text{HO}_2\text{CCH}_2\text{CH}_2\text{CO}_2\text{Na} + \text{NaOH} \rightarrow \text{NaO}_2\text{CCH}_2\text{CH}_2\text{CO}_2\text{Na} + \text{H}_2\text{O}$	[1] [1]
		[Total: 9]
6 (a) (i)	$\text{C}_6\text{H}_5\text{NO}_2 + 6\text{e}^- + 6\text{H}^+ \longrightarrow \text{C}_6\text{H}_5\text{NH}_2 + 2\text{H}_2\text{O}$	[1]
(ii)	$2\text{C}_6\text{H}_5\text{NO}_2 + 14\text{HCl} + 3\text{Sn} \rightarrow 2\text{C}_6\text{H}_5\text{NH}_3\text{Cl} + 3\text{SnCl}_4 + 4\text{H}_2\text{O}$	[2]
(b)	(M <sub>r</sub> values: C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub> = 123 C <sub>6</sub> H <sub>5</sub> NH <sub>3</sub> Cl = 129.5) theoretical yield = $5.0 \times 129.5/123 = 5.26\text{ g}$ percentage yield = $100 \times 4.2/5.26 = 79.8\%$ (80%)	[1] [1]
(c) (i)	C <sub>6</sub> H <sub>5</sub> NH <sub>2</sub> = 93 yield of phenylamine = $4.2 \times 93/129.5 = 3.016\text{ g}$	[1]
(ii)	mass left in water = $3.016 - 2.68 = 0.336\text{ g}$ $K_{\text{part}} = (2.68/50)/(0.336/25) = 3.99$	[1] [1]
(d)	phenylamine is less basic than ethylamine the lone pair on N is delocalised over the ring... ...making it less available for reaction with a proton/δ+ H	[2]
(e) (i)	step 1: HNO <sub>2</sub> OR (NaNO <sub>2</sub> + HCl) at $T \leq 10^\circ\text{C}$ step 2: boil/heat in water	[1] [1]
(ii)	E is 	[1]
		[Total: 13]

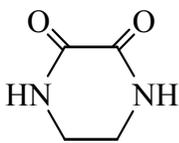
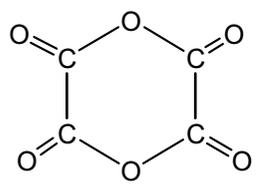
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Question	Answer	Marks
7 (a) (i)		[2]
(ii)	$M_r = 233$	[1]
(b) (i)	$\text{NH}_2\text{CH}(\text{CH}_2\text{OH})\text{CO}_2^-$	[1]
(ii)	<b>F</b> is a DC power supply <b>G</b> is the anode OR positive electrode <b>I</b> is the cathode OR negative electrode <b>H</b> is filter paper (OR gel) soaked in <b>buffer</b> solution	[4]
(iii)	<b>P</b> is $\text{NH}_2\text{CH}_2\text{CO}_2^-$ or $\text{NH}_2\text{CH}_2\text{CO}_2\text{H}$ or glycine <b>S</b> is $[\text{ala-ser-gly}]^{(-)}$ glycine is the smallest, so travels fastest; tripeptide is the largest, so travels slowest	[1] [1] [1]
(c) (i)	heat with $\text{H}_3\text{O}^+$ OR heat with $\text{OH}^-(\text{aq})$	[1]
(ii)	hydrolysis	[1]
		[Total: 13]
8 (a)	$\Delta H = [2(-580) + 3(-286) + 3(-1438)] - [-2061 + 4(-437) + 3(-814)]$ $= -81 \text{ kJ mol}^{-1}$	[2]
(b) (i)	<i>cis-trans</i> OR geometrical	[1]

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(ii)	in a complex the d-orbitals are split into 2 energy levels colour is due to absorption of light (in visible region) electron promotion to higher orbital absorbs a photon the d-d energy gap is different for the two complexes, hence different colours	[1] [1] [1] [1]
		<b>[Total: 7]</b>
9 (a)	T is  U is 	[1] [1]
(b)	step 1: $C_6H_5COCl + AlCl_3$ (+ heat) step 2: $CH_3CH_2Cl + AlCl_3$ (+ heat) step 3: $Br_2$ + light (or heat) step 4: $KCN$ + heat (in ethanol) step 5: $H_3O^+$ OR $H^+$ in $H_2O$ OR $HCl$ (aq) etc AND heat/boil/reflux	[1] [1] [1] [1] [1]
(c)	step 1: electrophilic substitution OR nucleophilic substitution step 5: hydrolysis OR nucleophilic substitution	[1] [1]
		<b>[Total: 9]</b>
10 (a)	$n(MnO_4^-) = 0.02 \times 15.2/1000 = 3.04 \times 10^{-4} \text{ mol}$ $n(C_2O_4H_2) = 3.04 \times 10^{-4} \times 5/2 = 7.6 \times 10^{-4} \text{ (in } 25 \text{ cm}^3) = 3.04 \times 10^{-3} \text{ mol in } 100 \text{ cm}^3$ $M_r = 24 + 64 + 2 = 90$ mass of $C_2O_4H_2 = 3.04 \times 10^{-3} \times 90$ $= 0.2736 \text{ g (0.274)}$ percentage = $0.2736 \times 100/40 = 0.68\%$	[1] [1] [1]
(b) (i)	$SOCl_2$ or $PCl_5$ or $PCl_3$	[1]

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(ii)	<p><b>J</b> is <math>\text{CH}_3\text{OCO}-\text{COOCH}_3</math>  <b>K</b> is</p> 	[1]  [1]
(c) (i)	<p><math>\text{CH}_3</math> at <math>\delta</math> 15  <math>\text{CH}_2\text{O}</math> at <math>\delta</math> 65</p>	[1] [1]
(ii)	Only one peak, so only one type/environment of C atom	[1]
(d) (i)	<p><b>M</b> is <math>\text{HO}_2\text{C}-\text{CO}_2\text{H}</math>  <b>N</b> is <math>\text{CH}_3\text{OCO}-\text{CO}_2\text{H}</math>  <b>O</b> is <math>\text{CH}_3\text{OCO}-\text{COOCH}_3</math></p>	[3]
(ii)	<p><b>L</b> is</p> 	[1]
		[Total: 13]