
CHEMISTRY

9701/41

Paper 4 A Level Structured Questions

May/June 2016

MARK SCHEME

Maximum Mark: 100

Published

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Page 2	Mark Scheme	Syllabus	Paper
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Question	Answer	Marks
1 (a) (i)	$\text{Ca(OH)}_2 + \text{CO}_2 \longrightarrow \text{CaCO}_3 + \text{H}_2\text{O}$	[1]
(ii)	Ba(OH)_2 is soluble, OR BaCO_3 is insoluble	[1]
(iii)	Mg(OH)_2 is insoluble / not very soluble will not form ppt. of MgCO_3	[1] [1]
(b)	carbonates are more stable down the group due to increase in cationic size / radius (causing) less polarisation of CO_3^{2-} ion	[1] [1] [1]
(c)	radius of $\text{Ni}^{2+} = 0.070 \text{ nm}$; radius of $\text{Ca}^{2+} = 0.099 \text{ nm}$ so NiCO_3 decomposes more readily than CaCO_3	[1] [1]
		[Total: 9]
2 (a) (i)	Co: ... $3s^23p^63d^74s^2$ Co ²⁺ : ... $3s^23p^63d^7$	[1]
(ii)	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]

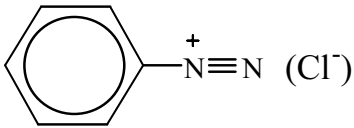
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Question	Answer	Marks
(b)		[1] [1] [1]
		[Total: 9]
3 (a)	$K_p = \frac{\{p(\text{CS}_2) \times (p(\text{H}_2))^4\}}{\{(p(\text{H}_2\text{S}))^2 \times p(\text{CH}_4)\}}$ units: atm^2 OR Pa^2	[1] [1]
(b) (i)	$p(\text{H}_2\text{S}) = 196 \text{ atm}$ $p(\text{H}_2) = 8 \text{ atm}$	[1] [1]
(ii)	$K_p = \frac{(2 \times 8^4)}{(196^2 \times 98)} = 2.176 \times 10^{-3}$	[1]
(c) (i)	ΔS^\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)	ΔG^\ominus will become less positive/more negative as T increases, ...because ΔS^\ominus is positive (or $-T\Delta S^\ominus$ is more negative) ...therefore the reaction becomes more feasible/spontaneous as T increases	[2]
		[Total: 10]

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4 (a) (i)	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 ⁻³)	[1]
(ii)	voltmeter and salt bridge	[1]
(iii)	A is Ag B is Ag ⁺ (aq) or AgNO ₃ (aq) C is Pt D is Fe ²⁺ (aq) and Fe ³⁺ (aq) (combination of A and B can be reversed with combination of C and D)	[3]
(b) (i)	Ag ⁺ + Fe ²⁺ → Ag + Fe ³⁺	[1]
(ii)	$E = E^{\circ} + 0.059 \log [\text{Ag}^+] = 0.80 - 0.03 = 0.77 \text{ V}$ so $E_{\text{cell}} = 0.77 - 0.77 = 0.0 \text{ V}$	[1] [1]
		[Total: 8]
5 (a) (i)	pK _a = -log K _a	[1]
(ii)	diacids are more acidic than CH ₃ CO ₂ H HO ₂ C– group is electron-withdrawing, stabilising the monoanion OR HO ₂ 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 ₂ H group OR the (intervening) alkyl groups destabilise the anion	[1] [1] [1]
(iii)	removing H ⁺ from an anion is not electrostatically favourable	[1]
(b) (i)	a solution which <i>resists</i> changes in pH when <i>small</i> amounts of H ⁺ or OH ⁻ are added	[1] [1]

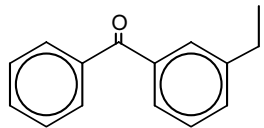
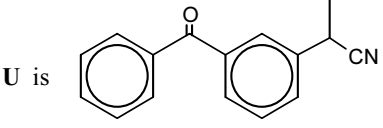
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(ii)	$\text{HO}_2\text{CCH}_2\text{CH}_2\text{CO}_2\text{Na} + \text{H}^+ \rightarrow \text{HO}_2\text{CCH}_2\text{CH}_2\text{CO}_2\text{H} + \text{Na}^+$ $\text{HO}_2\text{CCH}_2\text{CH}_2\text{CO}_2\text{Na} + \text{NaOH} \rightarrow \text{NaO}_2\text{CCH}_2\text{CH}_2\text{CO}_2\text{Na} + \text{H}_2\text{O}$	[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 _r values: C ₆ H ₅ NO ₂ = 123 C ₆ H ₅ NH ₃ 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 ₆ H ₅ NH ₂ = 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 ₂ OR (NaNO ₂ + HCl) at T ≤ 10 °C step 2: boil/heat in water	[1] [1]
(ii)	E is 	[1]
		[Total: 13]

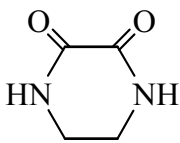
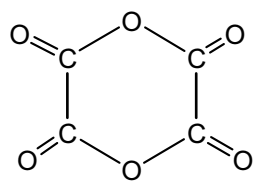
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Question	Answer	Marks
7 (a) (i)		[2]
(ii)	$M_r = 233$	[1]
(b) (i)	$\text{NH}_2\text{CH}(\text{CH}_2\text{OH})\text{CO}_2^-$	[1]
(ii)	F is a DC power supply G is the anode OR positive electrode I is the cathode OR negative electrode H is filter paper (OR gel) soaked in buffer solution	[4]
(iii)	P is $\text{NH}_2\text{CH}_2\text{CO}_2^-$ or $\text{NH}_2\text{CH}_2\text{CO}_2\text{H}$ or glycine S 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 H_3O^+ 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]
		[Total: 7]
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]
		[Total: 9]
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>J is $\text{CH}_3\text{OCO}-\text{COOCH}_3$ K is</p> 	[1] [1]
(c) (i)	<p>CH_3 at δ 15 CH_2O at δ 65</p>	[1] [1]
(ii)	Only one peak, so only one type/environment of C atom	[1]
(d) (i)	<p>M is $\text{HO}_2\text{C}-\text{CO}_2\text{H}$ N is $\text{CH}_3\text{OCO}-\text{CO}_2\text{H}$ O is $\text{CH}_3\text{OCO}-\text{COOCH}_3$</p>	[3]
(ii)	<p>L is</p> 	[1]
		[Total: 13]