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Cambridge International Advanced Subsidiary and Advanced Level

CHEMISTRY **9701/41**

Paper 4 A Level Structured Questions **May/June 2016**

MARK SCHEME

Maximum Mark: 100

Published

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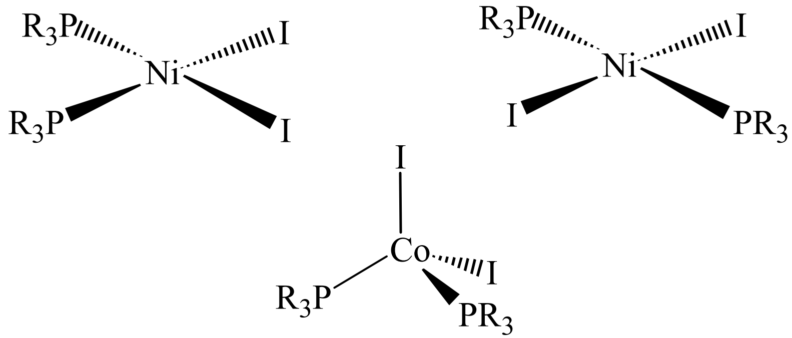
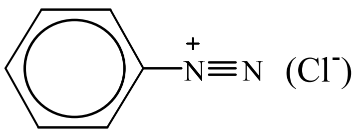
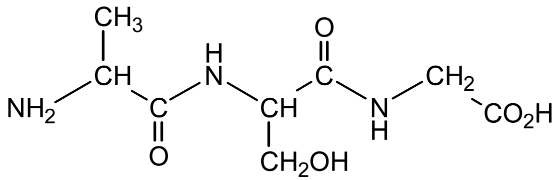
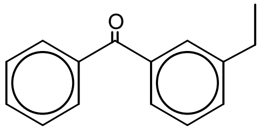
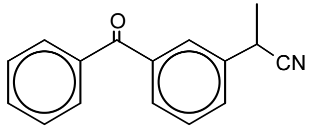
Question	Answer	Marks
1 (a) (i)	$Ca(OH)_2 + CO_2 \longrightarrow CaCO_3 + H_2O$	[1]
(ii)	$Ba(OH)_2$ is soluble, OR $BaCO_3$ is insoluble	[1]
(iii)	$Mg(OH)_2$ is insoluble / not very soluble will not form ppt. of $MgCO_3$	[1] [1]
(b)	carbonates are more stable down the group due to increase in cationic size / radius (causing) less polarisation of CO_3^{2-} ion	[1] [1] [1]
(c)	radius of Ni^{2+} = 0.070 nm; radius of Ca^{2+} = 0.099 nm so $NiCO_3$ decomposes more readily than $CaCO_3$	[1] [1]
		[Total: 9]
2 (a) (i)	Co: ...$3s^2 3p^6 3d^7 4s^2$ Co^{2+}: ...$3s^2 3p^6 3d^7$	[1]
(ii)	solution starts pink turns blue pink is $[Co(H_2O)_6]^{2+}$ blue is $[CoCl_4]^{2-}$ this complex is tetrahedral	[1] [1] [1] [1] [1]

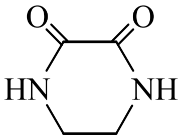
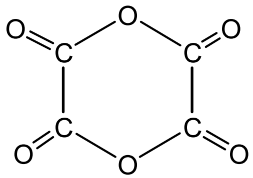
Question	Answer	Marks
(b)		[1] [1] [1]
		[Total: 9]
3 (a)	$K_p = \{p(CS_2) \times (p(H_2))^4\} / \{(p(H_2S))^2 \times p(CH_4)\}$ units: atm^2 OR Pa^2	[1] [1]
(b) (i)	$p(H_2S)$ = 196 atm $p(H_2)$ = 8 atm	[1] [1]
(ii)	$K_p = (2 \times 8^4) / (196^2 \times 98) = 2.176 \times 10^{-3}$	[1]
(c) (i)	$\Delta S^\ominus$ will be positive, because more gas moles on the RHS / products	[1]
(ii)	$\Delta S^\ominus = (\Delta H^\ominus - \Delta G^\ominus) / T = (241 - 51)/1000 = 0.19$ OR 190 $kJ\,mol^{-1}K^{-1}$ OR $J\,mol^{-1}K^{-1}$	[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]
		[Total: 10]

Question	Answer	Marks
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)	$Ag^+ + Fe^{2+} \longrightarrow Ag + Fe^{3+}$	[1]
(ii)	$E = E^{\ominus} + 0.059\log[Ag^+] = 0.80 - 0.03 = 0.77\,V$ so $E_{cell} = 0.77 - 0.77 = 0.0\,V$	[1] [1]
		[Total: 8]
5 (a) (i)	$pK_a = -\log K_a$	[1]
(ii)	diacids are more acidic than CH_3CO_2H HO_2C– group is electron-withdrawing, stabilising the monoanion OR HO_2C– 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_2H 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 *resists* changes in pH when *small* amounts of H^+ or OH^- are added	[1] [1]

Question	Answer	Marks
(ii)	$HO_2CCH_2CH_2CO_2Na + H^+ \rightarrow HO_2CCH_2CH_2CO_2H + Na^+$ $HO_2CCH_2CH_2CO_2Na + NaOH \rightarrow NaO_2CCH_2CH_2CO_2Na + H_2O$	[1] [1]
		[Total: 9]
6 (a) (i)	$C_6H_5NO_2 + \mathbf{6}e^- + \mathbf{6}H^+ \longrightarrow C_6H_5NH_2 + \mathbf{2}H_2O$	[1]
(ii)	$\mathbf{2}C_6H_5NO_2 + \mathbf{14}HCl + \mathbf{3}Sn \rightarrow \mathbf{2}C_6H_5NH_3Cl + \mathbf{3}SnCl_4 + \mathbf{4}H_2O$	[2]
(b)	(M_r values: $C_6H_5NO_2$ = 123 $C_6H_5NH_3Cl$ = 129.5) theoretical yield = 5.0 × 129.5/123 = 5.26 g percentage yield = 100 × 4.2/5.26 = 79.8% (80%)	[1] [1]
(c) (i)	$C_6H_5NH_2$ = 93 yield of phenylamine = 4.2 × 93/129.5 = 3.016 g	 [1]
(ii)	mass left in water = 3.016 – 2.68 = 0.336 g K_{part} = (2.68/50) / (0.336/25) = 3.99	[1] [1]
(d)	phenylamine is less basic that 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 $T \leqslant 10\,°C$ step 2: boil / heat in water	[1] [1]
(ii)	**E** is 	[1]
		[Total: 13]

Question	Answer	Marks
7 (a) (i)		[2]
(ii)	M_r = 233	[1]
(b) (i)	$NH_2CH(CH_2OH)CO_2^-$	[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 $NH_2CH_2CO_2^-$ *or* $NH_2CH_2CO_2H$ *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 $OH^-(aq)$	[1]
(ii)	hydrolysis	[1]
		[Total: 13]
8 (a)	ΔH = [2(–580) + 3(–286) + 3(–1438)] – [–2061 + 4(–437) + 3(–814)] = **–**81 $kJ\,mol^{-1}$	[2]
(b) (i)	*cis–trans* OR geometrical	[1]

Question	Answer	Marks
(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 HC*l* (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)	$n(MnO_4^-)$ = $0.02 \times 15.2/1000$ = 3.04×10^{-4} mol $n(C_2O_4H_2)$ = $3.04 \times 10^{-4} \times 5/2$ = 7.6×10^{-4} (in 25 cm^3) = 3.04×10^{-3} mol in 100 cm^3 M_r = 24 + 64 + 2 = 90 mass of $C_2O_4H_2$ = $3.04 \times 10^{-3} \times 90$ = 0.2736 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]

Question	Answer	Marks
(ii)	**J** is $CH_3OCO–COOCH_3$	[1]
	K is 	[1]
(c) (i)	CH_3 at δ 15 CH_2O at δ 65	[1] [1]
(ii)	Only one peak, so only one type / environment of C atom	[1]
(d) (i)	**M** is $HO_2C–CO_2H$ **N** is $CH_3OCO–CO_2H$ **O** is $CH_3OCO–COOCH_3$	[3]
(ii)	**L** is 	[1]
	[Total: 13]	