CHEMISTRY	**9701/43**
Paper 4 A Level Structured Questions	**May/June 2016**

MARK SCHEME

Maximum Mark: 100

Published

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Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.
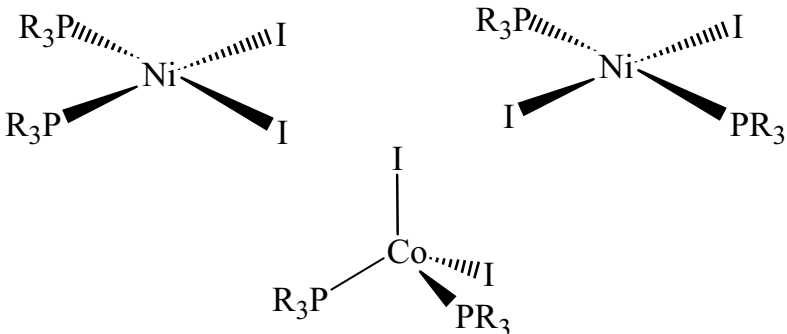
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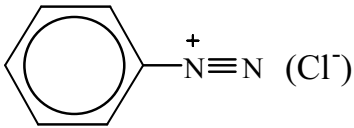| Question	Answer	Marks
1 (a) (i)	$Ca(OH)_2 + CO_2 \longrightarrow CaCO_3 + H_2O$	[1]
(ii)	$Ba(OH)_2$ is soluble, OR $BaCO_3$ is insoluble	[1]
(iii)	$Mg(OH)_2$ is insoluble / not very soluble will not form ppt. of $MgCO_3$	[1] [1]
(b)	carbonates are more stable down the group due to increase in cationic 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: $\quad$...$3s^23p^63d^74s^2$ Co^{2+}: $\quad$...$3s^23p^63d^7$	[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]

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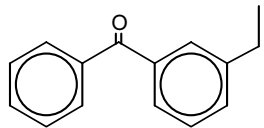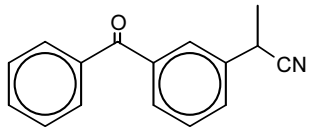| Question			Answer	Marks
4	(a)	(i)	SCP is the EMF / potential of a cell composed of two electrodes (OR half cells) under standard conditions (OR at 289 K OR 1 mol dm^{-3})	[1]
		(ii)	voltmeter and salt bridge	[1]
		(iii)	**A** is Ag **B** is Ag$^+$(aq) or AgNO$_3$(aq) **C** is Pt **D** is Fe^{2+}(aq) 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$_3$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 *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 $= 5.0 \times 129.5/123 = 5.26\,g$ percentage yield $= 100 \times 4.2/5.26 = 79.8\%$ (80%)	[1] [1]
(c) (i)	$C_6H_5NH_2 = 93$ yield of phenylamine $= 4.2 \times 93/129.5 = 3.016\,g$	[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$/\delta+$ 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]
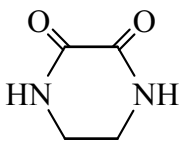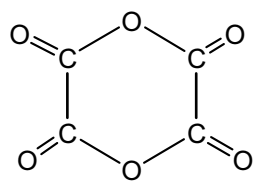
Question	Answer	Marks
7 (a) (i)		[2]
(ii)	M_r = 233	[1]
(b) (i)	$NH_2CH(CH_2OH)CO_2^-$	[1]
(ii)	**F** is a DC power supply **G** is the anode OR positive electrode **I** is the cathode OR negative electrode **H** is filter paper (OR gel) soaked in **buffer** solution	[4]
(iii)	**P** is $NH_2CH_2CO_2^-$ or $NH_2CH_2CO_2H$ or glycine **S** is [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 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)	$n(MnO_4^-)$ $= 0.02 \times 15.2 / 1000 = 3.04 \times 10^{-4}$ mol
	$n(C_2O_4H_2)$ $= 3.04 \times 10^{-4} \times 5/2 = 7.6 \times 10^{-4}$ (in 25 cm³) $= 3.04 \times 10^{-3}$ mol in 100 cm³
	$M_r = 24 + 64 + 2 = 90$
	                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]

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Question	Answer	Marks
(ii)	**J** is $CH_3OCO–COOCH_3$	[1]
	K is	[1]
(c) (i)	CH_3 at $\delta\,15$ CH_2O at $\delta\,65$	[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]