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GCE

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Chemistry (6244/01)

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Mark Scheme (Results)

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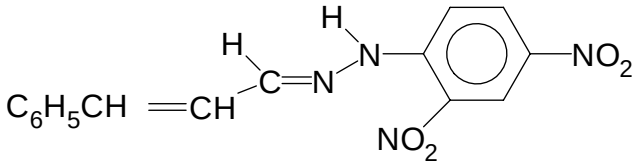
1.	(a)	(i)	$2Na + O_2 \rightarrow Na_2O_2$ *IGNORE state symbols* *NOT* $\rightarrow Na_2O$	**(1 mark)**
		(ii)	$4P + 5O_2 \rightarrow P_4O_{10}$ *OR* $4P + 5O_2 \rightarrow 2P_2O_5$ *OR* equations starting with P_4 species **(1)** – *IGNORE state symbols* balance **(1)** balanced equation forming phosphorus(III) oxide scores **(1)** only	**(2 marks)**
	(b)	$Al_2O_3 + 6H^+ \rightarrow 2Al^{3+} + 3H_2O$ **(1)** $Al_2O_3 + 2OH^- + 3H_2O \rightarrow 2Al(OH)_4^-$ *OR* $Al_2O_3 + 6OH^- + 3H_2O \rightarrow 2Al(OH)_6^{3-}$ *OR* $Al_2O_3 + 2OH^- \rightarrow 2AlO_2^- + H_2O$ **(1)** H^+ in one equation and OH^- in the other for acid and alkali on left of two equations. **(1)** *IGNORE spurious species* *Non-ionic equations can score 3rd mark only*.		**(3 marks)**
	(c)	(i)	mol^3dm^{-9}	**(1 mark)**
		(ii)	$[OH^-] = 2(1.31x10^{-4}) = 2.62x10^{-4}$ (mol dm^{-3}) **(1)** $[H^+] = 10^{-14} / 2.62 \times 10^{-4} = 3.82 \times 10^{-11}$ (mol dm^{-3}) *OR* pOH = 3.58 **(1)** $pH = -lg(3.82x10^{-11}) = 10.4(2)$ *OR* pH 14-3.58=10.4(2) **(1)** *NOT* just '10' If $[OH^-] = 1.31 \times 10^{-4}$ pH = 10.12 **(max 2)** *Consequential on $[H^+] \rightarrow$ pH for 3rd mark only if pH > 7*	**(3 marks)**

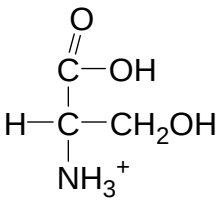
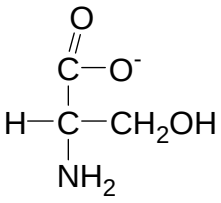
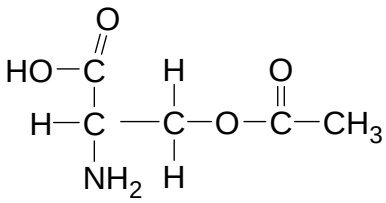
	(d)	(i)	$Mg(OH)_2(s) + H_2SO_4(aq) \rightarrow MgSO_4(aq) + 2H_2O(l)$ equation **(1)** state symbols **(1)** – *only if species correct* *OR* $Mg(OH)_2(s) + 2H^+(aq) \rightarrow Mg^{2+}(aq) + 2H_2O(l)$	**(2 marks)**
		(ii)	barium sulphate is insoluble *OR* less soluble than magnesium sulphate / solubility of sulphates decreases down group **(1)** *NOT* just 'it is insoluble' and is therefore a barrier (to further reaction) *OR* coats solid **(1)**	**(2 marks)**
				Total for Question: 14 marks

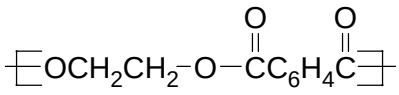
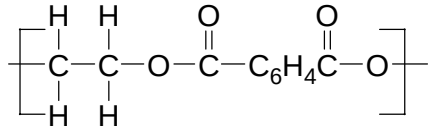
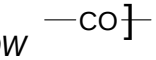
2	(a)	(i)	yellow / orange/red **and** precipitate / crystals / solid *NOT* solution	**(1 mark)**
		(ii)	C=N bond **(1)** Rest of molecule **(1)**  *IGNORE position of NO_2 groups*	**(2 marks)**
		(iii)	(warm with) Fehling's/Benedict's solution **(1)** red ppt **(1)** *mention of copper(II) oxide negates 2nd mark* *OR* (warm with alkaline) ammoniacal silver nitrate / Tollens' reagent **(1)** silver mirror **(1)** *reference to Ag^{2+} / Ag^{3+} negates 1st mark* *ALLOW* acidified (potassium) dichromate **(1)** orange to green/blue **(1)** *NOT* potassium manganate(VII)	**(2 marks)**
		(iv)	ketone cannot be oxidised / not a reducing agent	**(1 mark)**
	(b)	(i)	HCN **(1)** + KCN **(1)** *OR* HCN **(1)** base **(1)** *OR* HCN or KCN **(1)** pH5-9 **(1)** *OR* KCN **(1)** acid (except **conc** H_2SO_4) **(1)** *ALLOW* CN^- for KCN	**(2 marks)**
		(ii)	Four **(1)** It has geometric/cis-trans **and** optical isomers/C atom with four different groups/chiral carbon atom/asymmetric carbon *OR* it has both types of **stereo**-isomerism **(1) –** *stand alone*	**(2 marks)**

	(c)	(i)	reduction *OR* nucleophilic addition *ALLOW* redox *NOT* hydrogenation	**(1 mark)**
		(ii)	$C_6H_5CH=CHCH(OH)CH_2NH_2$ *MUST show C=C* *OR* formation of amine salt	**(1 mark)**
	(d)	(i)	(dry) ether / ethoxyethane	**(1 mark)**
		(ii)	Grignard reagents react with water ALLOW "It reacts with water to form an **alkane**"	**(1 mark)**
		(iii)	$C_6H_5CH=CHCH(OH)CH_2CH_3$ *C=C bond need not be shown* *ALLOW* C_2H_5 for CH_2CH_3	**(1 mark)**
		(iv)	Secondary Do NOT allow if primary or tertiary drawn in (iii)	**(1 mark)**
				Total for Question: 16 marks

3	(a)	$K_p = \frac{p^2(NO_2)}{p(N_2O_4)}$ **(1)** *NOT* [ ]		**(1 mark)**
	(b)		equilibrium moles $N_2O_4 = 0.2$ *OR* 20 $NO_2 = 1.6$ *OR* 160 **(1)** mole fractions $x_{N_2O_4} = \frac{0.2}{1.8} = 0.111$ and $x_{NO_2} = \frac{1.6}{1.8} = 0.889$ **(1)** partial pressures $p_{N_2O_4} = \frac{0.2}{1.8} \times 6.75 = 0.75$ (atm) and $p_{NO_2} = \frac{1.6}{1.8} \times 6.75 = 6$ (atm) **(1)** 48 **(1)** atm **(1)** *IGNORE S.F.* *Note:* *If moles $NO_2 = 0.8$, $K_p = 21.6$ atm* *If moles $NO_2 = 0.2$ and moles $N_2O_4 = 0.8$, $K_p = 0.338$ atm*	**(5 marks)**
	(c)	(i)	Reaction is endothermic **(1)** K_p increases **(1)** Therefore equilibrium position shifts to the right / forward direction **(1)** *3rd mark can only be awarded if it follows a change in K_p*	**(3 marks)**
		(ii)	equilibrium mixture gets **darker** / **more** brown *Consequential on answer to (c)(i)*	**(1 mark)**
				Total for Question: 10 marks

4	(a)		enthalpy /heat change for production of one mole of gaseous atoms **(1)** *ALLOW* **'**energy change**'** *NOT awarded if exothermic process stated or implied* *Gaseous can be awarded from RHS of equation* from an **element** in its standard state **(1)** *ALLOW "element under standard conditions"* ½ $I_2(s) \rightarrow I(g)$ **(1)** *State symbols required* *NOT multiples*	**(3 marks)**
	(b)	(i)	state symbols of Li species i.e. LiI(s), Li(s), Li(g), $Li^+(g)$ **(1)** species **(1)** *IGNORE stoichiometry*	**(2 marks)**
		(ii)	*Either* LE = –270 – (+159) – (+107) – (+520) – (–295) *OR* -270 = (+159) + (+107) + (+520) + (-295) + (LE) **(1)** -761 (kJ mol^{-1}) **(1)** *If units stated these must be correct* *Consequential on numbers and signs*	**(2 marks)**
	(c)		magnesium **ion** is small **and** highly/2+ charged OR magnesium **ion** has high charge density **(1)** leading to polarisation of the (large) iodide ion **(1)** ALLOW distortion of **electron cloud of** (large) iodide ion and (causing) covalency (into the lattice) *OR* theoretical value assumes magnesium iodide is 100 % ionic *OR* magnesium iodide is not 100 % ionic **(1)** *If atoms or molecules mentioned, only the 3rd mark is available.*	**(3 marks)**
				Total for Question: 10 marks

5.	(a)	(i)	$NH_3^+CH(CH_2OH)COO^-$ *If all bonds drawn, + must be shown on N*	**(1 mark)**
		(ii)	**high energy** needed to overcome (strong) **ionic** attractions/strong **ionic** bonds **(1)** between (different) zwitterion**s** *OR* between molecules [*if ions have been mentioned*] **(1)** Max (1) if intermolecular forces mentioned out of context	**(2 marks)**
	(b)	(i)	 *ALLOW COOH / CO_2H and IGNORE position of charge on NH_3^+ unless drawn in full*	**(1 mark)**
		(ii)	 *ALLOW* COO^- *OR* CO_2^-	**(1 mark)**
		(iii)	 or esterified zwitterion *ALLOW COOH on acid but ester group must be drawn* *ALLOW substituted amide as alternative to, or in addition to, ester*	**(1 mark)**

	(c)	(i)	$HOCH_2CH_2OH$	**(1 mark)**
		(ii)	 OR  brackets optional *ALLOW*  *at right hand side* ester link **(1)** *ALLOW* –OCO– / –OOC– (*as link was required in (b)(iii))* rest of repeat unit, including continuation bonds **(1)**	**(2 marks)**
	(d)	(i)	hydrolysis / nucleophilic substitution/saponification	**(1 mark)**
		(ii)	only goes one way / goes to completion / irreversible with NaOH/not an equilibrium **(1)** reaction with acid is reversible/is an equilibrium **(1)** (so yield is improved with alkali) *OR* both reagents catalyse the reaction **(1)** hydroxide ions react with product to prevent reverse reaction **(1)** (so yield is improved with alkali)	**(2 marks)**
				Total for Question: 12 marks

6.	(a)		starts at 2.2 **(1)** vertical section at 40cm^3 of sodium hydroxide **(1)** vertical section centred between pH 8-9 and between 2 to 3 squares high **(1)** shape to include initial jump and finish between pH = 12-13 **(1)** If curve drawn back to front, only 2nd and 3rd marks available	**(4 marks)**
	(b)	(i)	maintains **nearly** constant pH / resists change in pH **(1)** on adding **small amounts** of acid or alkali **(1)**	**(2 marks)**
		(ii)	$[H^+] = \frac{Ka[acid]}{[salt]}$ *OR* $pH = pK_a - \lg \frac{[acid]}{[salt]}$ **(1)** $[H^+] = 1.78 \times 10^{-4} \times \frac{0.25}{0.125}$ **(1)** $[H^+] = 3.56 \times 10^{-4}$ (mol dm^{-3}) pH = 3.4(5) **(1)** *IGNORE no. of decimal places but penalise pH = 3*	**(3 marks)**
		(iii)	acid partially ionised and salt fully ionised *OR* equations **(1)** $HA + OH^- \rightarrow A^- + H_2O$ **(1)** *ALLOW* $H^+ + OH^- \rightarrow H_2O$ followed by more dissociation of HA $A^- + H^+ \rightarrow HA$ **(1)** [HA] **and** [A$^-$] are large (relative to H^+ and OH^- added)/ large reserves of undissociated acid **and** salt (and so the values of [HA] and [A$^-$] do not change significantly) **(1)** NOTE: If no equations given for effect of adding OH^- and H^+, correct explanation can score **(1)** out of these two marks.	**(4 marks)**
				Total for Question: 13 marks
				TOTAL FOR PAPER: 75 MARKS