ANDERSON JUNIOR COLLEGE
2009 PRELIMINARY EXAMINATION
HIGHER 2 CHEMISTRY PAPER 2 ANSWERS

1 (a) S has more protons than Al, and since shielding effect remains almost constant, effective nuclear charge in S is larger than Al. More energy required to remove the 1st electron from S, resulting in a higher first ionisation energy for S than Al.

(b) (i) Aluminium oxide has giant ionic structure with strong electrostatic forces of attraction between Al^{3+} and O^{2-} ions.

Sulfur dioxide (or trioxide) has a simple covalent structure with covalent bonds between S and O atoms and weak van der Waals' forces of attraction (i.d. – i.d.) between the molecules.

(ii) Aluminium oxide is insoluble in water. Sulfur dioxide (or trioxide) dissolves in water to give an acidic solution.

SO_2 (g) + H_2O (l) → H_2SO_3 (aq) pH = 2

OR

SO_3 (g) + H_2O (l) → H_2SO_4 (aq) pH = 1

(c) (i) $2Al + 2NaOH + 6H_2O \rightarrow \mathbf{2}NaAl(OH)_4 + 3H_2$ (or ionic equation)

(ii) Using pV = nRT

$(1.01 \times 10^5) \times (0.71 \times 10^{-3}) = n \times 8.31 \times (40 + 273)$

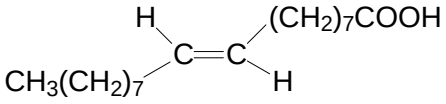
No. of moles of H_2 = **<u>0.0276 mol</u>**

(iii) No. of moles of Al = $\frac{2}{3}$ x no. of moles of H_2 = $\frac{2}{3}$ x 0.0276 = 0.0184 mol

Mass of Al = 0.0184 x 27.0 = 0.496 g

% mass of Al in alloy sample = $\frac{0.496}{1.00} \times 100\%$ = **<u>49.6 %</u>**

(d)



(e) (i) Free radical substitution

Initiation : $Br_2 \xrightarrow{\text{uv light}} 2Br\bullet$

Propagation :

$CH_3(CH_2)_3CH_2CH_3 + Br\bullet \longrightarrow CH_3(CH_2)_3\dot{C}HCH_3 + HBr$

$CH_3(CH_2)_3\dot{C}HCH_3 + Br_2 \longrightarrow CH_3(CH_2)_3CHBrCH_3 + Br\bullet$

Termination :

$Br\bullet + Br\bullet \longrightarrow Br_2$

$CH_3(CH_2)_3\dot{C}HCH_3 + Br\bullet \longrightarrow CH_3(CH_2)_3CHBrCH_3$

$2\ CH_3(CH_2)_3\dot{C}HCH_3 \longrightarrow CH_3(CH_2)_3CH(CH_3)CH(CH_3)(CH_2)_3CH_3$

(ii) Step 1: excess conc H_2SO_4, heat at 180^oC

Step 2: $KMnO_4$ (aq), dilute H_2SO_4, cold

(iii) $CH_3CH_2CH_2CH_2\underset{\displaystyle OH}{\underset{|}{C}}HCH_3$

2 (a) (i) $K_c = \dfrac{[B][H_2O]}{[RCOOH][R'OH]}$

(ii)

	RCOOH	+ R'OH	⇌	**B**	+ H_2O
initial	3	3		0	0
change	- 1.94	- 1.94		+ 1.94	+1.94
eqm	1.06	1.06		1.94	1.94

$K_c = \dfrac{(1.94)^2}{(1.06)^2} =$ **<u>3.35</u>**

(b) (i) There is a loss of compound **B**; concentration of reactants decreases and more water is formed. When amount / concentration of **D** decreases, according to Le Chatelier's Principle, the position of equilibrium shifts to the right to increase **D**.

(ii) The value of K_c remains unchanged as temperature is unchanged.

(c) (i) To separate test tubes containing compound **B** and **C** :

Add 2,4 – DNPH (at room temperature)
Orange ppt formed for Compound **C** but not for **B**.

OR

Add neutral aqueous $FeCl_3$ (at room temperature)
Violet colouration observed for Compound **C** but not for **B**.

OR

Add NaOH (aq), I_2 (aq) and warm
Yellow ppt formed for **C** but not for **B**.

(ii) To separate test tubes containing compound **B** and **D** :

Add dilute HCl (or H_2SO_4) and heat.
Then add excess aqueous NaOH, aqueous I_2 and warm.
Yellow ppt observed for products formed from Compound **D** but not for **B**.

OR

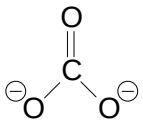
Add dilute NaOH and heat.
Then add aqueous I_2 and warm.
Yellow ppt observed for products formed from Compound **D** but not for **B**.

3 (a) (i) $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$

(ii) From *Data Booklet*: Zn^{2+} : 0.074 nm; Ca^{2+} : 0.099 nm

Since Zn^{2+} has a larger cationic radius than Ca^{2+}, the charge density of Zn^{2+} is larger and it has a higher polarizing power than Ca^{2+}. This leads to a greater distortion of CO_3^{2-} electron cloud, thus there is greater weakening of bonds in CO_3^{2-}. ∴ thermal stability of $ZnCO_3 < CaCO_3$.

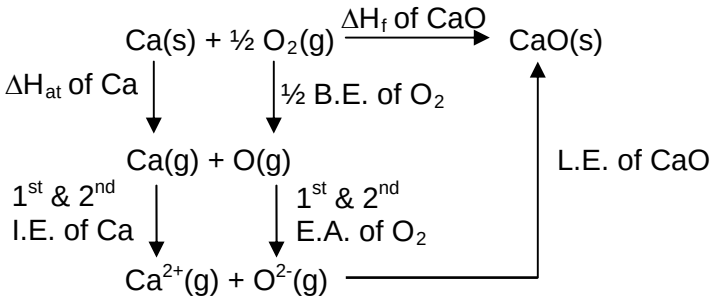
(iii)



(b) (i) Lattice energy of CaO is the heat evolved when one mole of solid CaO is formed from its gaseous Ca^{2+} and O^{2-} ions under standard conditions (of 298K and 1 atm).

$Ca^{2+}(g) + O^{2-}(g) \rightarrow CaO(s)$

(ii)

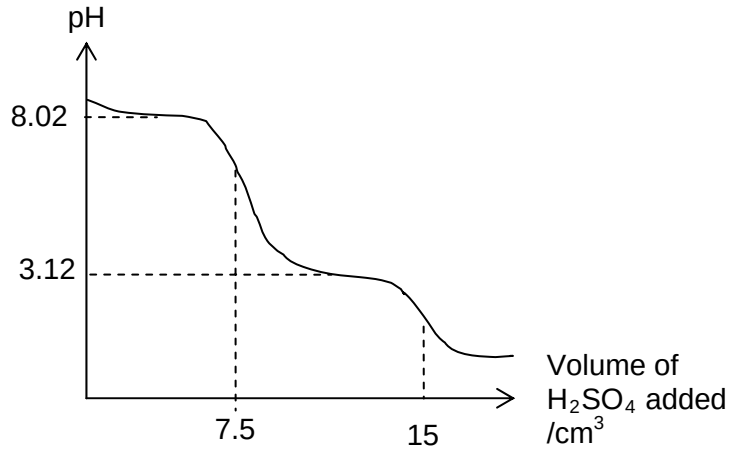


∴ Lattice energy of CaO
= - (590 + 1150) – (+657) – (147) – ½ (496) + (-635) = **- 2247 kJ mol^{-1}**

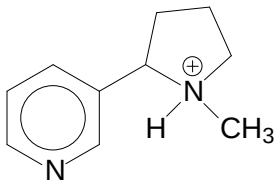
(c) Step **1**
Observations : Green ppt in colourless solution
Cation ppted : Fe^{2+}

Step **2**
Observations : White ppt in colourless solution
Cation ppted : Pb^{2+}

4 (a)



(b)

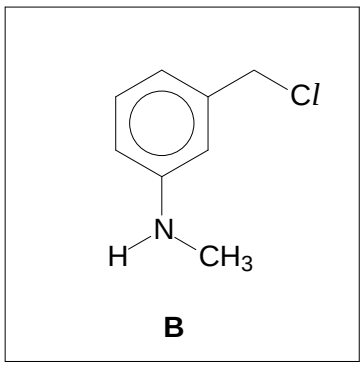


(c)

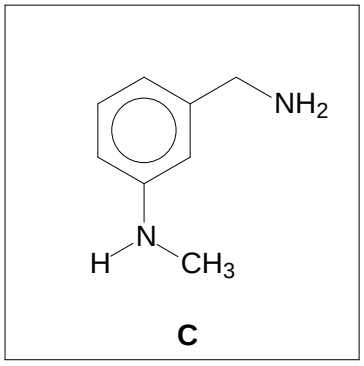
	1	2	3	
cathode	arginine	alanine	glutamic acid	anode

5 **(a)** Step **I** : CH_3Cl; heat in sealed tube
Step **II** : NH_3; heat in a sealed tube
Step **III** : CH_3COCl; room temperature

(b)

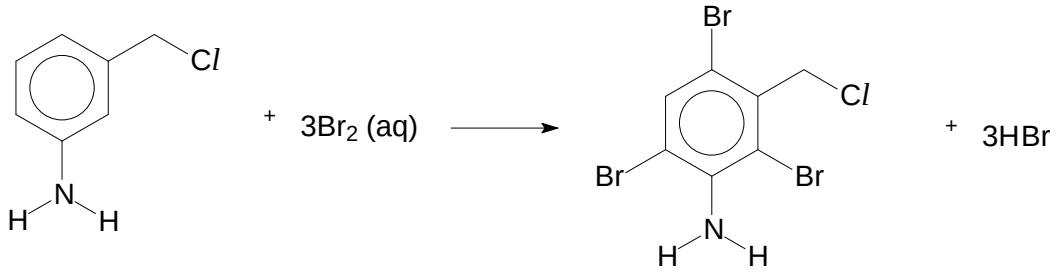


B



C

(c) **(i)**



(ii)