`MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY

FORM SIX

MARKING SCHEME

CHEMISTRY 3C

Question One

Volume of pipette used = 20.00cm^3

Table of results

	Pilot	I	II	III
Initial burette reading (cm^3)	0.000	0.00	0.00	0.00
Final burette reading (cm^3) Under POP	10.30	10.20	10.10	10.20
Final burette reading (cm^3) Under (MO)	25.70	25.40	25.50	25.40
Titer volume (cm^3) Under (POP)	10.30	10.20	10.10	10.20
Titer volume (cm^3) Under (MO)	15.70	15.40	15.50	15.40

Average titre volume under POP = $\frac{V1+V2+V3}{3} = \frac{10.20+10.10+10.20}{3}$ $\frac{V1+V2+V3}{3} = \frac{10.20+10.10+10.20}{3}$ =10.17 cm^3 (00 ½ Mark)

Average titre volume (Under MO) = $\frac{V1+V2+V3}{3} = \frac{15.40+15.50+15.40}{3}$ $\frac{V1+V2+V3}{3} = \frac{15.40+15.50+15.40}{3}$ = 15.43cm^3 (00 ½ Mark)

Distribution of marks on the table of result should be as follows;

- well completed table (C.T) 01 mark
- Decimal place (DP) 01 Mark
- Accurace (AC) 01 marks

Summary

20.00cm^3 of solution B_1 required 10.17 cm^3 of solution B_2 under POP and 15.430cm^3 of B_2 under MO. (01 mark)

(a) Molarity of solution B_2.
Given concentration of HCl 14.6 g/dm^3
Molar mass of HCl = (1+ 35.5) g/mol = 36.5g/mol
Molarity (14.6/36.5) mol/dm^3 = 0.4M (01 mark)
From a dilution law.

$M_1V_1 = M_2V_2$ 00½ marks

$M_1 = 0.4M.$

$V_1 = 100cm^3$

M_2=? 00½ marks

$V_2 = 200cm^3.$

$$M_2 = \frac{M_1V_1}{V_2} \frac{M_1V_1}{V_2}$$

$$M_2 = \frac{0.4M \times 100cm3}{200cm3} \frac{0.4M \times 100cm3}{200cm3}$$

00½ marks

$M_2 = 0.2M.$

Molarity f solution $B_2 = 0.2M$ 00½ marks

(b) volume required to neutralize

i. Na_2CO_3 only.

Volume under POP × 2

10.17 cm^3× 2

= 20.34 cm^3 (00½ Mark)

ii. $NaHCO_3$ only

=15.43

But Original $NaHCO_3$ which is pure is Volume of B_2 under MO –Volume of B_2 under POP

= (15.43 -10.17) cm^3

=5.26 cm^3 (00½ mark)

(c) Molarity of (i) $NaHCO_3$

Consider the chemical equation below

$NaHCO_3(aq) + HCl(aq) \longrightarrow NaCl\ (aq) + H_2O(aq) + CO_{2\ (g)}$.....,..(ii)

(00½)

Given:

Volume of acid (V_{B2}) to neutralize pure $NaHCO_3$ = 5.26 cm^3

Molarity of B_2 (M_{B2}) = 0.2M

Volume of Base (VB_1) = $20cm^3$

$$\frac{M_aV_a}{M_bV_b} \frac{M_aV_a}{M_bV_b} = \frac{na}{nb} \frac{na}{nb}$$

. (00½ Mark)

$\frac{0.2x5.26}{M_b x20} \frac{0.2x5.26}{M_b x20} = \frac{1}{1}\frac{1}{1}$ (00½ Mark)

Mb = 0.05M (00 ½ Marks)

Concentration in mass per liter solution = Molarity X molar mass

Molar mass of $NaHCO_3$ = 23+1+12+16x3 = 84 $g\ g$ /mol. (00½ mark)

$0.05mol/dm^3$ x 84g/mol (00 ½ Marks)

4.2 grams per litre solution. (4.2 $g\ g$ /dm^3). (00 ½ Mark)

ii) Molarity of Na_2CO_3

Consider the Chemical equation below

$Na_2CO_3(aq) + 2HCl(aq) \longrightarrow 2NaCl(aq) + H_2O(aq) + CO_{2(g)}$.....,..(ii)

Given:

Volume of acid (V_{B2}) to neutralize pure Na_2CO_3 = 20.34 cm^3 (00½ Mark)

Molarity of B_2 (M_{B2}) = 0.2M

Volume of Base (V_{B1}) = $20cm^3$

. $\frac{M_a V_a}{M_b V_b} \frac{M_a V_a}{M_b V_b} = \frac{na}{nb}\frac{na}{nb}$ (01 Mark)

$\frac{0.2x20.34}{M_b x20} \frac{0.2x20.34}{M_b x20} = \frac{2}{1}\frac{2}{1}$

Mb = 0.10M (00 ½ Mark)

Concentration in mass per liter solution = Molarity X molar mass

Molar mass of Na_2CO_3 = 23x2 + 12 + 16x3 = 106 $g\ g$ /mol. (00 ½ Mark)

$0.10mol/dm^3$ x 106g/mol (00 ½ Mark)

10.60 grams per litre solution. (10.6 $g\ g$ /dm^3).

Total mass of pure NaHCO3 and Na_2CO_3 = (4.2 + 10.6) grams (00½ Marks)

= 14.8 grams (00 ½ Mark)

(ii) $Na_2CO_3.X\ H_2O$.

Value of x.

Tota mass of Pure Na_2CO_3 and $NaHCO_3$ = 14.6 grams

But mass of sample mixture was 16.4 $\frac{g}{g}$ $\longrightarrow$ $500cm^3$

? $\longrightarrow$ $1000cm^3$

$$= \frac{16.4g\ x\ 1000cm3}{500cm3}$$

= 32.8 $\frac{g}{g}$ /dm^3 (01 mark)

Since Total mass of pure $NaHCO_3$ and Na_2CO_3 = 14.8 and Total mass of sample mixture is 32.8 their difference in mass is impurity due to the water of crystallization.

32.8 -14.8 = 18grams. (01 Mark)

	Na_2CO_3	H_2O
Mass	10.6	18
÷ molar mass	10.6/106 =0.1	18/18 =1
÷ by smallest	0.1/0.1 = 1	1/0.1 = 10

(1 Marks)

The ratio of Na_2CO_3 to H_2O is 1: 10 (00 ½ Marks)

Therefore the water of Crystallization = 10.

It is $Na_2CO_3.10\ H_2O$ (X = 10) 00½ marks

Question Two

Table of results Ti for NaOH was 23 ºC for Na_2CO_3 was 24 ºC

Substance	T_i	T_1	T_2	T_3	T_4	T_5	T_6	$\Delta T(°C)$ $(T_{max}-T_i)$
NaOH	23	26	29	35	41	40	38	18

Na_2CO_3	24	25	26.5	29	30	29.5	28	6

(03 Marks)

a) **i) Heat of solution of NaOH**

By using 5g of NaOH

$T_i = 23^0C$

$T_f = 41^OC$

$\Delta T = T_i - T_f$

$\Delta T = 18^OC$ Given: (00 ½ Mark)

density (ρ_{H2O}) = $1g/cm^3$

Specific heat capacity of water = 4.18Jg-1 k -1

$H_2O = 50cm^3$

Mass of water = $\rho_{water} \times V_{water}$

$= -1g/cm^3 \times 50cm^3$

=50g. (00 ½ Mark)

Heat of solution of NaOH

$q = -mc\Delta T$ (00 ½ Mark)

$q = -50g \times (4.18J/g\ ^oC) \times 18\ ^oC$ (00 ½ Mark)

$\underline{q = -3762J}$ (00 ½ Mark)

ii) Heat of Solution of Na_2CO_3

By using 5g of anhydrous Na_2CO_3

$T_I = 24^OC$

$T_2 = 30\ ^OC$

$\Delta T=T_2-T_1$

$\Delta T=+6^{O}C$

$\Delta T= 6\ ^{O}C$ (00 ½ Mark)

Heat of solution of Na_2CO_3

Given:

density (ρ_{H2O}) = $1g/cm^3$

Specific heat capacity of water = 4.18Jg⁻¹ k ⁻¹

$H_2O=50cm^3$

Mass of water = ρ_{water} x V_{water}

$=-1g/cm^3$ x $50cm^3$

=50g. (00 ½ Mark)

From: $q= -MC\ \Delta T$ (00 ½ Mark)

$q=-50g$ x (4.18 J/g ºC) x 6 ºC (00 ½ Mark)

$\underline{q= -1254\ J}$ (00 ½ Mark)

b) **i) Molar enthalpy of Solution NaOH**

moles of NaOH =m/Mr (00 ½Marks)

$\Delta H^{\ominus}$ soln=q/ṇ solute

Mr (NaOH) = 23 + 16 + 1= 40g/mol (00 ½ Mark)

Mr. NaOH= 5g/(40g/mols) (00 ½ Mark)

= 0.125moles (00 ½ Mark)

$\Delta H^{\ominus}$(solution) = $\underline{-3762J / 0.127moles}$ (00 ½ Mark)

=-30096 J/mol or 30.096 kJ/mol (00 ½ Mark)

ii) Molar enthalpy of solution of Na_2CO_3

But $\Delta H^{\ominus}$ soln=q/ṇ solute

Solute = m/mr (00 ½Marks)

Mr Na_2CO_3= 23x2 +12+16X3 = 106g/mol (00 ½Marks)

n=5g / 106g/mol (00 ½Marks)

=0.0472 mol (00 ½Marks)

Standard enthalpy of solution of Na_2CO_3= q= -1254 J /0.0472 (00 ½Marks)

Molar enthalpy = 26567.8 J/mol or 26.568 kJ/mol. (00 ½Marks)

c) **Assumption**
Assumption made here was neglecting heat loss due the polystyrene cup, density and specific heat capacity of solution assumed being of water. (01 Mark)

Question Three

s/n	Experiment	Observations	Inferences
1	The appearance	White crystalline sample x with no characteristic smell. (00½ Marks)	Transition element absent or non – transition element may be present (00½ Mark)
			CO_3^{2-}, HCO_3^- may be absent or so, NO_3^- , SO_4^{2-} or Cl^-may be present.
2	Addition of Con H_2SO_4 followed by warming.	Residue white when cold yellow when hot and white when cold (00½Mark)	Zn^{2+} may be present 00½ Mark)
		Colourless gas which turn wet blue litmus paper red and form white dense fumes with ammonia (00½Mark)	Cl^- present (00½ Mark)
3	Small amount of sample were heated in dry test tube	Colour less gas which turns wet blue litmus paper red and given dense white fumes with ammonia (00½ Mark)	Cl^- may be present (00½ Mark)

4	Sample solution was made and dissolved to four portion	Soluble in cold water to form a clear colourless solution (00½ Mark)	Soluble salt of or Cl^- may be present (00½ Mark)
	(i) Addition aqueous ammonia solution to first portion till excess	White gelatinous ppt soluble in excess ammonia solution were observed (00½Mark)	Zn^{2+} may be present (00½ Mark)
	(ii) Addition silver nitrate ($AgNO_3$) solution to second portion till excess	White ppt were observed (00½Marks)	Cl^- present and confirmed (01Mark)
	(iii) To third portion, barium chloride ($BaCl_2$) solution was added	White ppt were observed (00½Marks)	SO_4^{2-} Present and confirmed (01 Mark)
	(iv) To a small portion of a sample solution x, potassium hexacyabnoferrate (II) solution was added	White ppt were observed (00½Marks)	Zn^{2+} present and confirmed (00½ Mark)
	(v) OR. To a small portion of sample spolution x, dilNaOH solution was added till excess.	White ppt solution in excess NaOH. (00 ½ Mark) (Any one confirmatory test)	Zn^{2+} present and confirmed. (00½Mark)

conclusion:

(a) $Ag^+_{(aq)} + Cl^-_{(aq)} \rightarrow \rightarrow Agcl(s)$ ……. (01Mark)

$Ba^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)} \rightarrow \rightarrow BaSO_{4(s)}$ …… (01Mark)

(b) Zn^{2+} can be confirmed by using either:
Potassium hexacyanoferrate (II) any one …….. (00½ Mark)
Or Sodium Hydroxide (NaOH) solution.

(c) The cation is Zn^{2+} and anions are Cl^- and SO_4^{2-} ……(01 ½ Mark)