THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL

CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

032/2B **CHEMISTRY 2B**

(ACTUAL PRACTICAL B)

(For Both School and Private Candidates)

Time: 2:30 Hours **ANSWERS** **Year: 2003**

Instructions

1. This paper consists of two questions.

2. Answer all questions.

1. You are provided with the following solutions:
1.1 Solution P containing 28.60 g per litre of impure sodium carbonate
1.2 Solution Q containing 0.20 mole of hydrochloric acid in a litre of solution
1.3 Methyl orange as an indicator

PROCEDURE
Put the acid solution in a burette. Pipette 25 cm^3 of solution P into a titrating flask. Add a few drops of methyl orange indicator. Titrate solution P against the acid solution until the end point is reached. Repeat this procedure until three titre values are obtained and record your titration results in a tabular form as shown below:

(a)(i) Table of results:

Titration	Final reading (cm^3)	Initial reading (cm^3)	Volume used (cm^3)
Pilot	25.00	0.00	25.00
1	24.90	0.00	24.90
2	25.00	0.00	25.00
3	25.00	0.00	25.00

(ii) Volume of pipette used = 25.00 cm^3
(iii) The mean titre is = (24.90 + 25.00 + 25.00) ÷ 3 = 24.97 cm^3
(iii) Summary: 25.00 cm^3 of solution P required 24.97 cm^3 of solution Q for complete reaction

(b) Write balanced equation for the above neutralization reaction
$Na_2CO_3 + 2HCl \text{ ----> } 2NaCl + H_2O + CO_2$

(c) Calculate the molarity of P:
(i) in moles per litre
Molarity of Q = 0.20 mol/dm^3
Volume of Q used = 24.97 cm^3 = 0.02497 dm^3
Moles of HCl = 0.20 × 0.02497 = 0.004994 mol
From the balanced equation: 2 mol HCl react with 1 mol Na_2CO_3
Moles of Na_2CO_3 = 0.004994 ÷ 2 = 0.002497 mol
Volume of P used = 25.00 cm^3 = 0.02500 dm^3
Molarity of P = 0.002497 ÷ 0.025 = 0.09988 mol/dm^3

(ii) in grams per litre
Molar mass of Na_2CO_3 = 106 g/mol
Concentration in g/dm^3 = 0.09988 × 106 = 10.59 g/dm^3

(d)(i) Calculate the amount of impurity in g per litre
Mass of impure sodium carbonate = 28.60 g
Mass of pure sodium carbonate = 10.59 g

Impurity = 28.60 − 10.59 = 18.01 g

(ii) If this impurity was due to water of crystallization in the salt, calculate the number of moles of water in one mole of sodium carbonate crystals
Molar mass of impure salt = 28.60 ÷ 0.09988 = 286.37 g/mol
Water of crystallization = 286.37 − 106 = 180.37 g
Number of moles of water = 180.37 ÷ 18 = 10.02 ≈ 10
So, number of water molecules = 10
Formula = $Na_2CO_3 \cdot 10H_2O$

2. Sample R is a simple salt containing ONE cation and ONE anion. Carry out carefully the experiments described below and record all your observations and inferences in the table. Identify the cation and anion present in the sample.

Test	Experiment	Observation	Inference
2.1	Appearance of R	White crystalline solid	Colourless ionic salt
2.2	Heat some of sample R in a hard glass test tube gently then strongly	No gas evolved	No water of crystallization
2.3	Add concentrated sulphuric acid on sample R	Effervescence, colourless gas turns limewater milky	CO_3^{2-} present (CO_2 gas evolved)
2.4	Dissolve some of R in water	Clear solution	Salt is soluble
2.5	Add NaOH dropwise and then in excess	White precipitate formed, insoluble in excess	Ca^{2+} likely
2.6	Add ammonium hydroxide dropwise and then in excess	White precipitate formed, insoluble in excess	Confirms Ca^{2+}
2.7	Add potassium ferrocyanide to solution of R	No visible reaction	Confirms absence of Fe^{3+}, Pb^{2+}
2.8	Add freshly prepared $FeSO_4$ and conc. H_2SO_4 carefully	No brown ring seen	Confirms absence of NO_3^-

Conclusion
Cation in R is Ca^{2+}
Anion in R is CO_3^{2-}
R is $CaCO_3$

3. Sample X contains ONE anion and ONE cation. Using systematic qualitative analysis procedures, carry out tests on X and make observations and inferences, hence identify the anion and cation present in sample X.

Test	Experiment	Observation	Inference
(a)	Observe the physical appearance of solid X	White crystalline solid	Colourless ionic compound
(b)	Heat a little of solid X in a dry test tube	Colourless gas evolved turns limewater milky	Presence of CO_3^{2-} (CO_2 gas)
(c)	Dissolve solid X in distilled water and shake	Colourless solution formed	Salt is soluble
(d)	Add dilute HCl to the solution of X	Effervescence observed	Confirms CO_3^{2-}
(e)	Add NaOH solution dropwise and then in excess to the solution of X	White precipitate, soluble in excess	Zn^{2+} present
(f)	Add aqueous NH_3 dropwise and then in excess to the solution of X	White precipitate, soluble in excess	Confirms Zn^{2+}
(g)	Add $BaCl_2$ to solution of X followed by dilute HCl	No precipitate	Absence of SO_4^{2-}
(h)	Add $AgNO_3$ to solution of X followed by HNO_3	No precipitate	Absence of Cl^-, Br^-, I^-
(i)	Add $Pb(NO_3)_2$ to solution of X	White precipitate formed	Confirms presence of CO_3^{2-}
(j)	Flame test on solid X	No characteristic flame colour	No alkali metal cation present

Conclusion
The cation present in X is Zn^{2+} and the anion present in X is CO_3^{2-}