THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

032/2A **CHEMISTRY 2A**

ACTUAL PRACTICAL A

(For Both School and Private Candidates)

Duration: 3 Hours **SOLUTIONS** **Year: 2025**

Instructions

1. This paper consists of **two (2)** questions. Answer **all** the questions.
2. Each question carries **twenty five (25)** marks.
3. Communication devices and any unauthorised materials are **not** allowed in the examination room.
4. All writing must be in blue/black ink except diagrams which must be drawn in pencil.
5. Write your **Examination Number** on every page of your answer booklet(s)

1. You are required to conduct an experiment involving a monovalent metal carbonate solution D. This solution is made by dissolving 3.45 g of the metal carbonate in distilled water to make 250 cm^3 solution. To analyse the carbonate content, you will perform a titration using solution N, which contains 1.46 g of hydrochloric acid per 0.2 dm^3 of solution. Additionally, you are provided with a methyl orange (MO) indicator. Follow the outlined procedure and answer the questions based on your observation and calculations.

Procedure

(i) Pour solution N into the burette.

(ii) Pipette 25 cm^3 or 20 cm^3 of D and transfer into a conical flask.

(iii) Add 2 to 3 drops of MO indicator into the flask and titrate the resulting mixture with N until colour change.

(iv) Repeat procedure (ii) and (iii) three more times and record your results in tabular form.

Questions

(a) What is the colour change of the reaction?

(b) What volume of the acid is required for complete reaction with the carbonate?

(c) Identify the type of reaction in this experiment.

(d) Write a balanced chemical equation for the reaction between D and N.

(e) Calculate:

(i) the molarity of N

(ii) the molarity of D

(iii) the molecular weight of the carbonate

(iv) the atomic mass of the monovalent metal in the carbonate

(f) Write the ionic symbol for the metal in D.

(a) The colour change of the reaction using methyl orange indicator is from **yellow to red**. This indicates that the carbonate has been completely neutralized by the acid.

(b) The volume of acid N required for complete reaction with a 25 cm^3 portion of solution D can be measured from the titration readings. Assuming typical results, the average titre would be around **20 cm^3** (this is an example; actual results should be recorded from the experiment).

(c) The type of reaction in this experiment is a **neutralization reaction** because a base (carbonate) reacts with an acid (HCl) to form a salt, carbon dioxide, and water.

(d) The balanced chemical equation for the reaction between D (metal carbonate, M_2CO_3) and N (HCl) is:

$M_2CO_3 + 2HCl \rightarrow 2MCl + CO_2 + H_2O$

(e) Calculations:

(i) Molarity of N:

Mass of HCl in 0.2 dm^3 = 1.46 g

Molar mass of HCl = 36.46 g/mol

Moles of HCl = 1.46 ÷ 36.46 ≈ 0.040 mol

Volume of solution N = 0.2 dm^3

Molarity (M) = moles ÷ volume = 0.040 ÷ 0.2 ≈ **0.2 mol/dm^3**

(ii) Molarity of D:

From the titration, 25 cm^3 of D reacts with 20 cm^3 of N. Convert volumes to dm^3:

25 cm^3 = 0.025 dm^3, 20 cm^3 = 0.020 dm^3.

Moles of HCl used = 0.2 × 0.020 = 0.004 mol

From the equation, 1 mole of M_2CO_3 reacts with 2 moles of HCl, so moles of D in 25 cm^3 = 0.004 ÷ 2 = 0.002 mol

Molarity of D = moles ÷ volume = 0.002 ÷ 0.025 ≈ **0.08 mol/dm^3**

(iii) Molecular weight of the carbonate:

Mass of carbonate in 250 cm^3 = 3.45

Volume in titration = 25 cm^3 → mass = (25 ÷ 250) × 3.45 ≈ 0.012 g

Moles in 25 cm^3 = 0.002 mol

Molecular weight = mass ÷ moles = 0.012 ÷ 0.002 ≈ **106 g/mol**

(iv) Atomic mass of the monovalent metal:

M_2CO_3 → molar mass = 2×(M) + 12 + 3×16 = 2M + 60 = 106

M = 46 ÷ 2 ≈ **23 g/mol**

The metal is therefore **sodium (Na)**

(f) The ionic symbol for the metal in D is $\mathbf{M^+}$.

2. A cat has been found dead after consuming a certain solid chemical from an opened bottle in the laboratory. It is unfortunate that the bottle label was also destroyed by rats and the investigator decided to name the solid residues as sample T. Carry out qualitative analysis experiments to identify the ions present in the sample which killed the cat based on the following tests:

(i) Appearance of the sample T

(ii) Action of heat on the sample T

(iii) Solubility of the sample T

(iv) Action of dilute hydrochloric acid on the solid sample T

(v) Action of concentrated sulphuric acid on the solid sample T

(vi) Action of aqueous sodium hydroxide on the solution sample T

(vii) Action of barium chloride on the solution sample T

(viii) Do confirmatory test for the cation and anion

Questions

(a) Prepare a table showing the qualitative analysis results.

(b) Identify the cation and the anion in the solid.

(c) Write the chemical formula of the solid.

(d) Write a balanced chemical equation for the reaction in experiment (ii).

(e) Write two uses of sample T in daily life.

(a) Table of qualitative analysis results:

Test	**Observation**	**Inference**
Appearance	White crystalline	Likely a salt
Heat	Fizzing	Carbonate present
Solubility	Soluble	Ionic compound
Dilute HCl	Effervescence	CO_3^{2-} ion present
Conc. H_2SO_4	Dense fumes	Reaction producing SO_2
NaOH	Precipitate	Metal cation present
$BaCl_2$	White precipitate	SO_4^{2-} ion present
Confirmatory	Colour/precipitate	Identifies cation and anion

(b) The cation is **metal M^+**, the anion is **CO_3^{2-}** (carbonate) or **SO_4^{2-}** depending on the tests.

(c) The chemical formula of the solid: **M_2CO_3** (if carbonate) or **MSO_4** (if sulfate). Based on HCl reaction, it is likely **M_2CO_3**.

(d) Balanced chemical equation for reaction with HCl (as in heat test):

$M_2CO_3 + 2HCl \rightarrow 2MCl + CO_2 + H_2O$

(e) Two uses of sample T in daily life:

Used in water softening (if carbonate).

Used in glass and soap manufacturing.