

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)

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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 cm³ 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 dm³ 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 cm³ or 20 cm³ 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

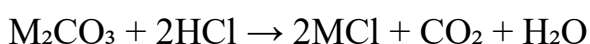
- (a) What is the colour change of the reaction?
- (b) What volume of the acid is required for complete reaction with the carbonate?
- (c) Identify the type of reaction in this experiment.
- (d) Write a balanced chemical equation for the reaction between D and N.
- (e) Calculate:
 - (i) the molarity 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 cm³ portion of solution D can be measured from the titration readings. Assuming typical results, the average titre would be around **20 cm³** (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, M₂CO₃) and N (HCl) is:



(e) Calculations:

(i) Molarity of N:

Mass of HCl in 0.2 dm³ = 1.46 g

Molar mass of HCl = 36.46 g/mol

Moles of HCl = $1.46 \div 36.46 \approx 0.040$ mol

Volume of solution N = 0.2 dm³

Molarity (M) = moles \div volume = $0.040 \div 0.2 \approx \mathbf{0.2 \text{ mol/dm}^3}$

(ii) Molarity of D:

From the titration, 25 cm³ of D reacts with 20 cm³ of N. Convert volumes to dm³:

25 cm³ = 0.025 dm³, 20 cm³ = 0.020 dm³.

Moles of HCl used = $0.2 \times 0.020 = 0.004$ mol

From the equation, 1 mole of M₂CO₃ reacts with 2 moles of HCl, so moles of D in

25 cm³ = $0.004 \div 2 = 0.002$ mol

Molarity of D = moles \div volume = $0.002 \div 0.025 \approx \mathbf{0.08 \text{ mol/dm}^3}$

(iii) Molecular weight of the carbonate:

Mass of carbonate in 250 cm³ = 3.45

Volume in titration = 25 cm³ → mass = (25 ÷ 250) × 3.45 ≈ 0.012 g

Moles in 25 cm³ = 0.002 mol

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

(iv) Atomic mass of the monovalent metal:

M₂CO₃ → 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 **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

- Prepare a table showing the qualitative analysis results.
- Identify the cation and the anion in the solid.
- Write the chemical formula of the solid.
- Write a balanced chemical equation for the reaction in experiment (ii).
- Write two uses of sample T in daily life.

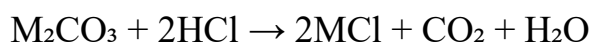
(a) Table of qualitative analysis results:

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 ₂ SO 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 **CO₃²⁻** (carbonate) or **SO₄²⁻** depending on the tests.

(c) The chemical formula of the solid: **M₂CO₃** (if carbonate) or **MSO₄** (if sulfate).
Based on HCl reaction, it is likely **M₂CO₃**.

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



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

Used in water softening (if carbonate).

Used in glass and soap manufacturing.