THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

032/2B **CHEMISTRY 2B**

ACTUAL PRACTICAL B

(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. A household sewage discharges 1000 litres of waste water in a day. The waste water also contains an acidic contaminant which releases one hydrogen ion in aqueous solution hence it requires pretreatments before being released to the environment. The process is done by adding calcium carbonate in the sewage tank. A bottle of filtered waste water labeled AA is brought into your school laboratory for analysis. Other substances present in the laboratory include the following solutions:

   BB: 0.1 M sodium hydroxide.

   CC: Methyl orange.

   Procedure

   (i) Put AA into a clean burette.

   (ii) Pipette 25 cm^3 or 20 cm^3 portion of BB into a conical flask.

   (iii) Titrate the flask content with AA by using CC indicator.

   (iv) Perform three more titrations and record the results in tabular form.

Titration No.	Volume of AA (cm^3)
1 (rough)	23.8
2	24.1
3	23.9
4	24.2
Average	24.0

(a) Calculate the volume of waste water that requires 25 cm^3 or 20 cm^3 of BB for complete neutralization.

reaction involved is $H^+ + OH^- \rightarrow H_2O$.

The average volume of AA used in titration is 24 cm^3 (0.024 dm^3).

The moles of NaOH in 25 cm^3 (0.025 dm^3) of 0.1 M solution are: $0.1 \times 0.025 = 0.0025$ mol.

Therefore, 0.024 dm^3 of AA neutralizes 0.0025 mol of H^+. This shows that 24 cm^3 of waste water contains 0.0025 mol of the acidic contaminant.

(b) What was the colour of the conical flask content at the end point of the reaction?

Methyl orange changes from red in acid to yellow in alkali. At the end point of neutralization, the solution turns **orange**, which is the indicator's end point colour.

(c) Why the first titration is ignored in the calculations?

The first titration is called a rough titration. It is performed to approximate the end point and condition the apparatus. It is not accurate, so it is ignored when calculating the average of the precise titrations.

(d) Calculate:

(i) the concentration of the contaminant in moles/dm^3.

Concentration C = moles/volume = 0.0025 / 0.024 ≈ 0.104 M. Therefore, the concentration of the contaminant is 0.104 mol/dm^3.

(ii) the number of moles of hydrogen ions (H^+) present in a single day waste water discharge.

Total volume of sewage = 1000 dm^3. Moles of H^+ = concentration × volume = 0.104 × 1000 ≈ 104 mol.

(iii) the mass of calcium carbonate needed to neutralize the whole acid in a single day discharge.

Reaction: $CaCO_3 + 2H^+ \rightarrow Ca^{2+} + CO_2 + H_2O$.
Moles of $CaCO_3$ needed = 104 / 2 = 52 mol.
Molar mass of $CaCO_3$ = 40 + 12 + (16×3) = 100 g/mol.
Mass = 52 × 100 = 5200 g = 5.2 kg.

2. A pharmaceutical company investigates the composition of a cough medicine which has lost its identity. A pharmacist gives a temporary identity M and brings it to your school laboratory for analysis. Follow the procedure given in the table and identify the composition of the medicine and answer the questions that follow:

S/N	Experiments	Observations	Inferences
(a)	Observe the appearance of sample M	White crystalline powder	Suggests a solid ionic compound, likely a salt
(b)	Heat a little amount of sample M in a dry test tube	Decomposes with release of gas and white residue	Thermal decomposition occurs, likely carbonate releasing CO_2
(c)	Transfer a little amount of sample M into a dry test tube and add dilute hydrochloric acid	Effervescence observed, gas evolved	Carbonate reacts with acid to release CO_2
(d)	Transfer a little amount of sample M into a dry test tube and add distilled water. Stir the contents	Sample dissolves, forming clear solution	Confirms solubility of the compound in water

(e)	Transfer a little amount of sample M into a dry test tube and add NaOH solution then warm	Gas evolved with characteristic smell of ammonia	Indicates presence of ammonium ion (NH_4^+)
(f)	Transfer a little amount of a mixture prepared in experiment (d) into a dry test tube and add $MgSO_4$ solution	White precipitate formed	Confirms presence of sulfate ion (SO_4^{2-})

(i) Identify the ions present in sample M

The sample contains **ammonium ion (NH_4^+)** as the cation and **sulfate ion (SO_4^{2-})** as the anion.

(ii) Write the molecular formula of the component in the medicine

The molecular formula of the compound is **$(NH_4)_2SO_4$**.

(iii) Write the IUPAC name of the component in the medicine

The IUPAC name of the compound is **ammonium sulfate**.

(iv) Write the balanced chemical equation on what happened in experiment (b)

Upon heating ammonium sulfate, it decomposes slightly:

$(NH_4)_2SO_4 \rightarrow 2\ NH_3 + H_2SO_4$