THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

032/2 **CHEMISTRY 2**

ALTERNATIVE TO PRACTICAL

(For Both School and Private Candidates)

Time: 3 Hours **ANSWERS** **Year: 1997**

Instructions

1. This paper consists of five questions. Answer all questions.

2. Each question carries 10 marks

1. (a) Give the name of each of the pieces of apparatus labeled A, B, C, D, E, F, G, H, I, and J.

A - Tripod stand
B - Crucible tongs
C - Wire gauze
D - Filter funnel
E - Conical flask
F - Test tube
G - Liebig condenser
H - Pipette
I - Measuring cylinder
J - Evaporating dish

(b) Give at least one use of the apparatus labeled C, D, H, I, and J.

C - Wire gauze: Used to support glassware on a tripod stand when heating.
D - Filter funnel: Used for filtration to separate solids from liquids.
H - Pipette: Used to measure a fixed volume of liquid accurately.
I - Measuring cylinder: Used to measure liquid volumes accurately.
J - Evaporating dish: Used for evaporating solvents to concentrate solutions.

2. (a) Define the following terms:

(i) A standard solution
A solution of accurately known concentration used in titrations.

(ii) A 1.0 molar solution
A solution that contains 1 mole of solute dissolved in 1 dm^3 (1000 cm^3) of solution.

(iii) Molarity
The number of moles of solute dissolved per liter (dm^3) of solution.

(b) Copy and complete the table below:

Name of Indicator	Colour in Acidic Solution	Colour in Alkaline Solution
Methyl Orange	Red	Yellow
Phenolphthalein	Colourless	Pink
Litmus	Red	Blue

(c) Samples of sodium hydroxide solution of unknown concentration were titrated against 0.2M ethanoic acid, and the results are as tabulated below.

Volume of pipette used = 10 cm^3

Burette Readings (cm^3)	PILOT	1	2	3
Final Reading	21.50	25.00	30.00	40.00
Initial Reading	1.00	10.00	10.05	20.00
Titre Volume	20.50	15.00	19.95	20.00

(i) Find the average volume of the acid used.
Average titre = (15.00 + 19.95 + 20.00) / 3 = 18.32 cm^3

(ii) The chemical equation of the reaction is:
$NaOH\ (aq) + CH_3COOH\ (aq) \rightarrow CH_3COONa\ (aq) + H_2O\ (l)$

(iii) Calculate the molarity of the sodium hydroxide solution and its concentration in g/dm^3.
Moles of CH_3COOH used = 0.2 × (18.32 / 1000)
= 0.003664 moles

Since the reaction ratio is 1:1,
Moles of NaOH = 0.003664

Molarity of NaOH = moles / volume in dm^3
= 0.003664 / (10 / 1000)
= 0.3664 M
Concentration in g/dm^3 = Molarity × Molar mass of NaOH
= 0.3664 × 40
= 14.66 g/dm^3
(iv) Name the most suitable indicator for this reaction.
Phenolphthalein

(v) If the indicator named in (iv) above was used, what would be the colour change at the end point of the titration?
The colour would change from pink to colourless.

3. (a) State the Faraday's 1st and 2nd laws of electrolysis.

Faraday's 1st Law: The mass of a substance deposited or liberated at an electrode during electrolysis is directly proportional to the quantity of electricity (charge) passed through the electrolyte.

Faraday's 2nd Law: When the same quantity of electricity is passed through different electrolytes, the masses of substances deposited or liberated at the electrodes are directly proportional to their equivalent masses.

(b) Two voltameters were connected in series as seen in the diagram below. One of the voltameters contained dilute sulfuric acid and the other contained dilute copper(II) sulfate solution. Platinum electrodes were used in both voltameters.

(i) What mass of copper would have been liberated by the time 125 cm^3 of hydrogen gas measured at STP had been collected from one of the electrodes?

From the electrolysis of sulfuric acid:
$2H^+ + 2e^- \text{----> } H_2$

At STP, 1 mole of H_2 occupies 22.4 dm^3 (22400 cm^3), so
Moles of H_2 = 125 / 22400 = 0.00558 moles

Since 2 moles of electrons produce 1 mole of H_2, the number of moles of electrons passed = 0.00558 × 2 = 0.01116 moles

In the Cu^{2+} electrolysis:
$Cu^{2+} + 2e^- \text{---> } Cu$

Since 2 moles of electrons deposit 1 mole of copper,
Moles of Cu deposited = 0.01116 / 2 = 0.00558 moles

Mass of Cu = moles × atomic mass
= 0.00558 × 63.5
= 0.354 g

(ii) Write balanced equations for all the reactions which took place in the copper(II) sulfate voltameter.

At the cathode:
$Cu^{2+} + 2e^- \text{---> } Cu$

At the anode:
$Cu \text{----> } Cu^{2+} + 2e^-$

Overall reaction:
$Cu\ (s) \text{----> } Cu^{2+}\ (aq) + 2e^-$

(iii) Explain the color changes which would be observed if the electrolysis was allowed to continue to completion.

The blue color of the copper(II) sulfate solution would fade as Cu^{2+} ions are removed from the solution and deposited at the cathode. The solution would become colorless when all Cu^{2+} ions are removed.

4. Five grams of calcium carbonate were mixed with 250 cm^3 of 0.125M HCl solution. The carbon dioxide evolved was collected, measured, and corrected to STP. Measurements were taken after every twenty minutes, and the results are given in the table below.

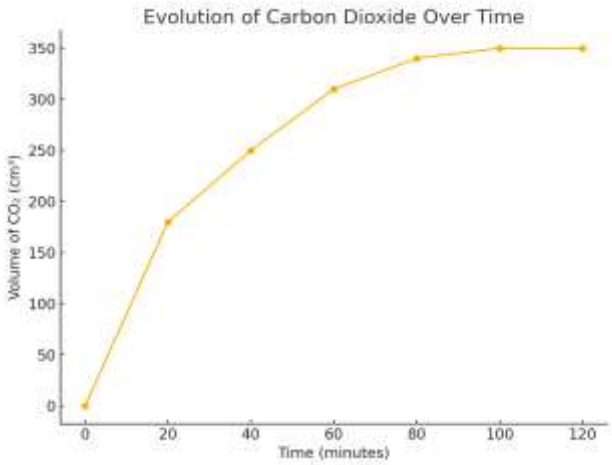
Time (minutes)	0	20	40	60	80	100	120
Volume of CO_2 (cm^3)	0	180	250	310	340	350	350

(a) In this experiment, calcium carbonate was present in excess. What mass of this substance was consumed in the process?

Reaction equation:
$CaCO_3 + 2HCl \longrightarrow CaCl_2 + CO_2 + H_2O$

Moles of HCl in 250 cm^3 of 0.125M solution = $0.125 \times 250 / 1000 = 0.03125$ moles
From the equation, 2 moles of HCl react with 1 mole of $CaCO_3$, so
Moles of $CaCO_3 = 0.03125 / 2 = 0.01563$ moles

Mass of $CaCO_3$ = moles × molar mass
$= 0.01563 \times 100$
$= 1.56$ g
(b) Draw a graph to show how the evolution of carbon dioxide varied with time.



(c) After how many minutes was all the acid completely finished?
From the table, the volume of CO_2 stops increasing at 100 minutes, indicating that all the acid was consumed.

5. The table below shows the experiments and the observations for the qualitative analysis of an unknown sample, X, which contains one anion and one cation. Complete the table and identify the anion, the cation, and the compound X.

Experiment	Observation	Inference
(i) Appearance of sample X	White crystalline	The salt is an ionic compound.
(ii) A sample of solid X was heated in a test tube.	White vapors were formed and these condensed on the cooler parts of the test tube.	Presence of ammonium salts.
(iii) Three drops of dilute NaOH solution were added to solid sample X, warmed, and the gas given off was tested.	The gas given off formed white dense fumes with gaseous hydrogen chloride.	Confirms presence of ammonium (NH_4^+) ions.
(iv) To a portion of solid X in a dry test tube, conc. H_2SO_4 was added, the mixture was warmed, and the gas given off was tested.	The gas given off formed white dense fumes with gaseous ammonia.	Confirms presence of chloride (Cl^-) ions.
(v) To another portion of solid X in a test tube, MnO_2 and conc. H_2SO_4 were added and the mixture was slightly warmed. The gas given off was passed over wet litmus paper.	The yellowish-green gas given off bleached the wet litmus paper.	Confirms presence of chloride (Cl^-) ions due to chlorine gas formation.
(vi) To an aqueous solution of substance X, aqueous silver nitrate was added, followed by excess aqueous ammonia solution with shaking.	The white precipitate formed dissolved in the aqueous ammonia solution.	Confirms presence of chloride (Cl^-) ions.

The anion is chloride (Cl^-).
The cation is ammonium (NH_4^+).
The compound X is ammonium chloride (NH_4Cl).