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: November 1999**

Instructions

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

2. Each question carries 10 marks

1. Study carefully the following diagram which represents a laboratory preparation of a certain gas then answer the following questions below.

(a) Name the parts labeled A, B, C, D, E, and F.
A - Delivery tube
B - Calcium hydroxide ($Ca(OH)_2$) solution
C - Flask containing ammonium chloride and calcium hydroxide
D - Clamp
E - Gas jar
F - Water trough

(b) If the diagram represents laboratory preparation of ammonia, what chemical compound should be reacted with slaked lime in order to produce the gas?
Ammonium chloride (NH_4Cl).

(c) What is the chemical compound represented by letter G?
Ammonia gas (NH_3).

(d) Write a chemical equation which explains the functions of substance G.
$NH_3 + H_2O$ -----> NH_4OH

(e) Write an ionic equation for the reaction described in (b) above.
$NH_4^+ + OH^-$ -----> $NH_3 + H_2O$
(f) Explain by giving two reasons why the gas is collected as it is shown in the diagram above.
Ammonia is less dense than air, so it is collected by upward delivery.
Ammonia is highly soluble in water, so it cannot be collected over water.
2. (a) Complete the following table of indicators and their colour changes in different solutions.

INDICATOR	ACID SOLUTION	NEUTRAL SOLUTION	ALKALINE SOLUTION
Litmus	Red	Purple	Blue
Methyl Orange	Red	Orange	Yellow
Phenolphthalein	Colourless	Colourless	Pink

(b) Give the names of indicators that are suitable for the following titrations.

- Strong acid against strong base: Methyl orange or phenolphthalein
- Strong acid against weak base: Methyl orange
- Weak acid against strong base: Phenolphthalein

(c) Why do we put a white tile under a conical flask during titrations?
To make it easier to observe the color change at the endpoint.

(d) What is meant by the following terms which are used in volumetric analysis?
(i) Molar solution
A solution that contains one mole of a solute in one liter of solution.

(ii) Standard solution
A solution of known concentration used in titration.

(e) 25.00 cm^3 of standard sodium carbonate solution made by dissolving 1.31 g of the anhydrous salt in 250 cm^3 of distilled water were titrated with dilute hydrochloric acid until two results within 0.1 cm^3 of one another were obtained. The indicator used was methyl orange. The results were tabulated as follows.

TITRATION	TRIAL	1	2
Final burette reading (cm^3)	25.00	24.60	24.80
Initial burette reading (cm^3)	0.00	0.00	0.00
Volume used (cm^3)	25.00	24.60	24.80

(i) Complete the table above.
Table completed as shown.
(ii) What was the average volume of the acid used?
(24.60 + 24.80) / 2 = 24.70 cm^3

(iii) Write a balanced chemical equation for the reaction.
$Na_2CO_3 + 2HCl \rightarrow 2NaCl + CO_2 + H_2O$

(iv) Calculate the concentration of sodium carbonate in g/dm^3.
Molar mass of $Na_2CO_3 = 23\times2 + 12 + 16\times3 = 106$ g/mol
Mass of Na_2CO_3 used = 1.31 g
Concentration = $(1.31 / 250) \times 1000 = 5.24$ g/dm^3

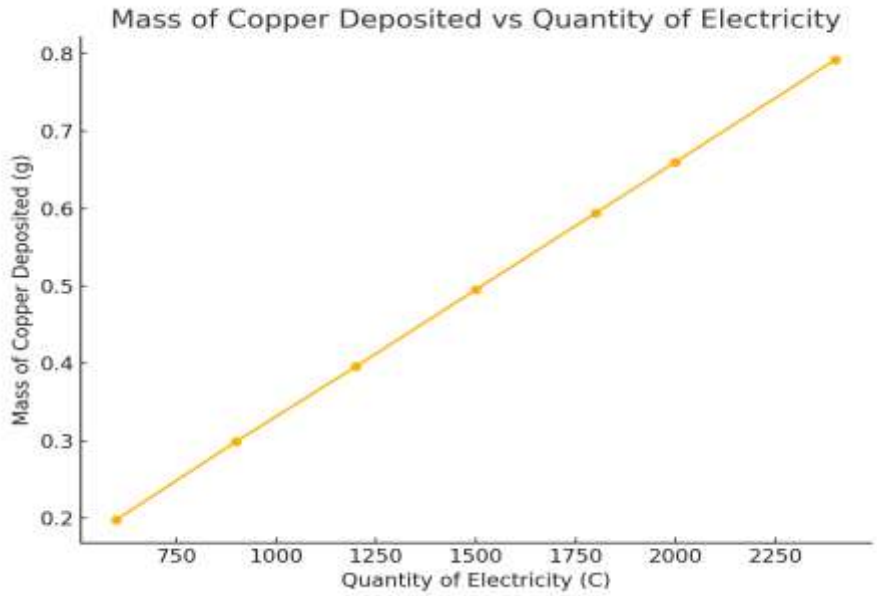
(v) How many moles of sodium carbonate were used in this experiment?
Moles = mass / molar mass
= 1.31 / 106
= 0.01236 moles

3. A solution of copper(II) sulfate was electrolyzed using copper electrodes. The cathode electrode was weighed before and after the electrolysis. The experiment was repeated several times using different quantities of electricity and the following data were obtained.

QUANTITY OF ELECTRICITY (C)	MASS OF COPPER DEPOSITED (g)
600	0.198
900	0.299

1200	0.396	
1500	0.495	
1800	0.594	
2000	0.660	
2400	0.792	

(a) Draw a graph of these results, plotting the quantity of electricity on the x-axis and the mass of copper on the y-axis.



(b) From the graph find:
(i) The slope
Slope = Change in mass of Cu / Change in electricity
= (0.792 - 0.198) / (2400 - 600)
= 0.594 / 1800
= 0.00033 g/C

(ii) The mass deposited by 100 coulombs
Mass = 100 × 0.00033
= 0.033 g

4. An experiment was carried out in the laboratory where the following metals were reacted with Zinc, Copper, Magnesium, Iron, and Mercury.

(a) Write balanced chemical equations for the reactions described above.
$Zn + CuSO_4$ ----> $ZnSO_4 + Cu$
$Mg + FeSO_4$ -----> $MgSO_4 + Fe$
$Fe + CuSO_4$ ------> $FeSO_4 + Cu$
$Zn + HgCl_2$ -------> $ZnCl_2 + Hg$

(b) Arrange the metals according to increase in reactivity.
Mercury < Copper < Iron < Zinc < Magnesium

(c) Calculate the weight of hydrochloric acid which will react completely with 0.22 g of zinc metal.
$Zn + 2HCl \text{ -----> } ZnCl_2 + H_2$
Molar mass of Zn = 65 g/mol
Moles of Zn = 0.22 / 65 = 0.00338 moles
From the reaction, 1 mole of Zn reacts with 2 moles of HCl.
Moles of HCl required = 0.00338 × 2 = 0.00676 moles
Mass of HCl = moles × molar mass
= 0.00676 × 36.5
= 0.247 g

5. (a) Sample M is a simple salt containing one cation and one anion. Tests were carried out on sample M. The tests and observations made were recorded and entered in the table shown below. Complete the table and deduce the cation and anion present in M.

Test	Observations	Inference
(1) Appearance	A white deliquescent solid	The salt is hygroscopic and soluble in water.

| (2) To a spatulaful of M in a boiling tube, dilute hydrochloric acid was added and the mixture was warmed. | The solid simply dissolved in the dilute warm acid. | The salt is soluble in hydrochloric acid, indicating the presence of a soluble ionic compound. |

(3) To another spatulaful of M, concentrated sulfuric acid was added and the mixture was warmed.	A highly acidic gas was evolved. The gas formed white mists with gaseous ammonia.	Presence of chloride (Cl^-) ions due to production of hydrogen chloride (HCl) gas.
(4a) A solution of M in distilled water was made and then divided into six portions. To the first portion, aqueous ammonia was gradually added with shaking until it was in excess.	A white precipitate was formed. The precipitate dissolved in excess ammonia.	Confirms the presence of silver (Ag^+) ions.
(4b) To the second portion, sulfide gas was bubbled through.	A dirty white precipitate was observed.	Indicates presence of lead (Pb^{2+}) or silver (Ag^+) ions.
(4c) To the third portion, lead nitrate solution was added.	A white precipitate soluble in hot water was observed.	Indicates chloride (Cl^-) ions.
(4d) To the fourth portion, sodium hydrogen carbonate solution was added.	A white precipitate formed and an effervescence of a colorless gas which turned lime water milky was observed.	Confirms the presence of carbonate (CO_3^{2-}) ions due to release of CO_2 gas.
(4e) To the fifth portion, sodium carbonate solution was added.	A white precipitate was formed.	Indicates the presence of calcium (Ca^{2+}) or silver (Ag^+) ions.
(4f) To the sixth portion, potassium chromate solution was added.	A yellow precipitate was formed.	Confirms the presence of lead (Pb^{2+}) ions.

(b) (i) The cation was silver (Ag^+) and the anion was chloride (Cl^-).

(ii) Write the confirmatory tests for the cation and anion present in M.
For Ag^+: Add dilute HCl or NaCl solution; a white precipitate of AgCl forms, which dissolves in excess ammonia.
For Cl^-: Add silver nitrate solution; a white precipitate forms, which dissolves in excess ammonia.

(iii) The equation for the reaction in test 4(c):
$Pb^{2+} + 2Cl^- \text{----> } PbCl_2$ (white precipitate)

(iv) The equation for the reaction in test 4(d):
$NaHCO_3 + HCl \text{ ---> } NaCl + CO_2 + H_2O$