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: 2003**

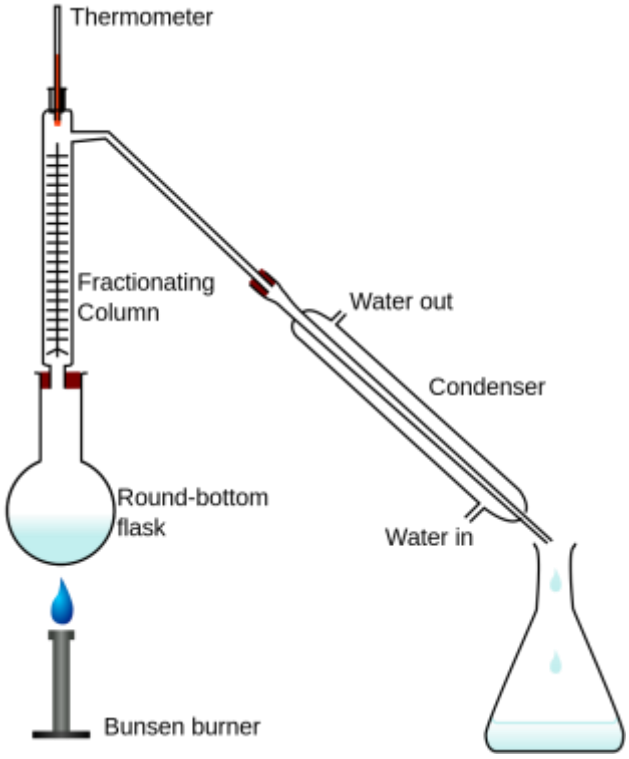
Instructions

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

2. Each question carries 10 marks

1. Study the diagrams for the pieces of apparatus labeled A, B, C, D, and E.

(a) Draw a diagram to show how the pieces of apparatus above can be connected in a distillation experiment.



(b) Give the names and uses of the apparatus A, B, C, D, and E.

A - Round-bottom flask: Used for heating liquids in distillation and other chemical reactions.
B - Clamp and stand: Used to hold apparatus in place during experiments.
C - Thermometer: Used to measure temperature during experiments.
D - Conical flask: Used to collect distilled liquid in distillation or for titrations.
E - Liebig condenser: Used to cool and condense vapor back to liquid in distillation.

2. 5.2 g of sodium hydroxide contaminated with sodium chloride was dissolved in water, and the volume was corrected to 1 liter of the solution T_2. 25 cm^3 of solution T_2 were pipetted into a conical flask and titrated.

(a) Table of results.

Titration number	Pilot	1	2	3
Final reading (cm^3)	27.00	48.00	45.00	48.00
Initial reading (cm^3)	1.00	25.00	25.05	24.95
Titre volume (cm^3)	26.00	25.00	25.05	24.95

(i) Complete the table by filling in the missing data.
Table completed as shown.

(ii) The colour change at the endpoint was from colourless to pink if phenolphthalein was used or from yellow to red if methyl orange was used.

(iii) Write a balanced chemical equation for the reaction between sodium hydroxide and sulfuric acid.
$2NaOH + H_2SO_4$ ------> $Na_2SO_4 + 2H_2O$

(iv) Calculate the average titre volume.
$(25.00 + 25.05 + 24.95) / 3 = 25.00\ cm^3$

(b) Calculate:

(i) The molarity of the solution of sulfuric acid, T_1.
Moles of NaOH = Molarity × Volume (in dm^3)
= M × (25 / 1000)

From the equation, 2 moles of NaOH react with 1 mole of H_2SO_4, so
Moles of H_2SO_4 = (M × 25 / 1000) ÷ 2

Molarity of H_2SO_4 = Moles / Volume
= ((M × 25 / 1000) ÷ 2) ÷ (25 / 1000)
= M / 2

(ii) The molarity of sodium hydroxide in solution T_2.
Moles of H_2SO_4 = Molarity × Volume
= (M / 2) × (25 / 1000)
= M × 12.5 / 1000

Since 1 mole of H_2SO_4 reacts with 2 moles of NaOH,
Moles of NaOH = 2 × (M × 12.5 / 1000)
= M × 25 / 1000

Molarity of NaOH = M × 25 / 1000 ÷ (25 / 1000)
= M

(iii) The concentration in g/dm^3 of sodium hydroxide in solution T_2.
Concentration = Molarity × Molar mass
= M × 40

(iv) The mass of sodium chloride in solution T_2.

Mass of total solid = 5.2 g
Mass of NaOH = M × 40 × 1 (since volume is 1 dm^3)
Mass of NaCl = 5.2 - (M × 40)

(v) The percentage by mass of sodium chloride which has contaminated the sodium hydroxide.
% NaCl = [(5.2 - (M × 40)) / 5.2] × 100

3. A student in a certain school did an experiment in order to compare the amount of different substances liberated by the same quantity of electricity. The student used a copper voltameter and a silver voltameter as shown in the diagram below.

(a) Which of the four electrodes labeled B, C, D, E in the diagram above are:

(i) Cathodes?
C and E

(ii) Anodes?
B and D

(b) By using ionic equations, show the chemical reactions which took place at:

(i) The cathode of the copper voltameter
$Cu^{2+} + 2e^- \text{---> } Cu$

(ii) The anode of the silver voltameter
$Ag \text{---> } Ag^+ + e^-$

(c) If a current of 0.45 amperes was allowed to flow through the copper voltameter and the silver voltameter for 25 minutes, calculate:

(i) The quantity of electricity in coulombs that passed through the two voltameters.
Q = It
= 0.45 × (25 × 60)
= 675 C

(ii) The mass of copper deposited.
From Faraday's law,
Mass = (Atomic mass × Q) / (n × 96500)
= (63.5 × 675) / (2 × 96500)
= 0.222 g

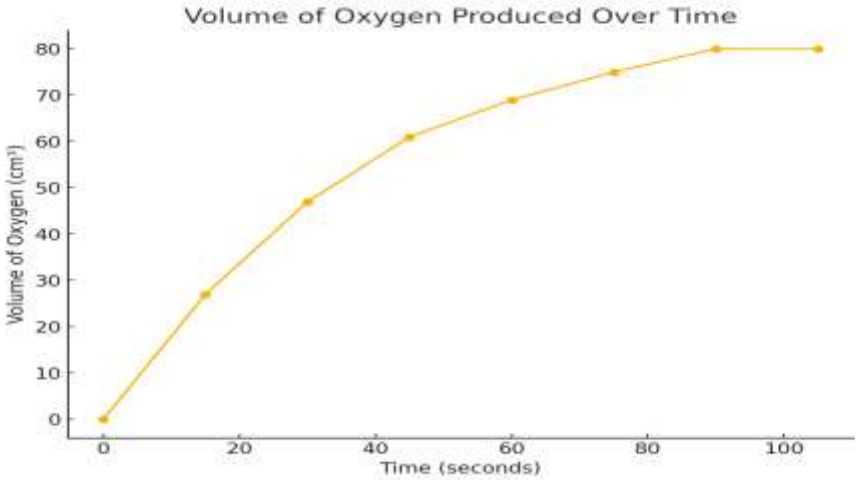
(iii) The mass of silver deposited.

= (108 × 675) / (1 × 96500)
= 0.756 g

4. A small flask was connected to a gas syringe by means of a stopper and delivery tube. 10 cm^3 of water, 0.5 g of manganese (IV) oxide, and 5 cm^3 of hydrogen peroxide were placed in the flask and quickly stoppered. The readings of the volume of oxygen gas in the syringe were recorded every 15 seconds as shown in the table below.

Time (s)	0	15	30	45	60	75	90	105
Volume (cm^3)	0	27	47	61	69	75	80	80

(a) (i) Plot a graph of volume of oxygen (in cm^3) against time (in sec.)



(ii) At what time interval was the reaction very fast?
The reaction was fastest in the first 30 seconds, as shown by the rapid increase in oxygen volume.

(iii) Why didn't the volume of oxygen produced increase any further after 90 to 105 seconds?
All the hydrogen peroxide had decomposed, so no more oxygen could be produced.

(b) (i) What will happen to the rate of decomposition of hydrogen peroxide if the volume of hydrogen peroxide is changed from 5 cm^3 to 8 cm^3 while the amount of water and manganese (IV) oxide remain constant?
The rate will increase since there will be more hydrogen peroxide molecules available for decomposition.

(ii) What is the effect of MnO_2 on the rate of decomposition of hydrogen peroxide?
MnO_2 acts as a catalyst, increasing the rate of decomposition without being consumed in the reaction.

5. Use the information given under the test and observation column to complete the inference column and lastly identify the cation and anion present in sample Q.

Test	Observation	Inference
(a) Appearance of sample Q	A colorless/white deliquescent salt.	The salt absorbs moisture from the air.

| (b) A little of sample Q was heated in a test tube. | A brownish gas accompanied with a gas which rekindles a glowing splint was evolved. | The brown gas indicates nitrogen dioxide (NO_2), suggesting the presence of nitrate ions (NO_3^-). The gas that rekindles a glowing splint is oxygen (O_2). |

| (c) Distilled water was added to a spatulaful of sample Q in a test tube, stirred, and the solution was divided into three portions. | A colorless solution was formed. | Sample Q is soluble in water. |

| (d) To the first portion of the solution of sample Q in a test tube, sodium hydroxide solution was added drop by drop until excess. | White precipitate insoluble in excess of the reagent was formed. | Indicates the presence of calcium (Ca^{2+}) or lead (Pb^{2+}) ions. |

| (e) Ammonium hydroxide solution was added drop by drop until excess to the second portion of the solution of sample Q in a test tube. | White precipitate insoluble in excess of the reagent was formed. | Confirms the presence of lead (Pb^{2+}) ions. |

| (f) To a quarter of a spatula of iron(II) sulfate in a test tube, a drop of concentrated sulfuric acid was added followed by 1 cm^3 of distilled water then stirred. The solution obtained was added to the third portion of the solution of sample Q obtained in (c) above, followed by concentrated sulfuric acid which was added slowly along the sides of the test tube. | A brownish liquid was formed between the two liquids. | Confirms the presence of nitrate (NO_3^-) ions through the brown ring test. |

| (g) A little Q on a nichrome wire was burnt in an open Bunsen burner flame. | Brick-red coloration was imparted in the Bunsen burner flame. | Confirms the presence of calcium (Ca^{2+}) ions. |

The anion is nitrate (NO_3^-).
The cation is calcium (Ca^{2+}).
The molecular formula of the salt Q is calcium nitrate, $Ca(NO_3)_2$.