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: 2011**

Instructions

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

2. Each question carries 10 marks

1. (a) Give name and one use of each of the following apparatus:

S/n	Name	Uses
(i)	Dropping pipette	Used to transfer small amounts of liquids dropwise.
(ii)	Tripod stand	Used to support beakers or flasks during heating.
(iii)	Glass stirring rod	Used for mixing solutions in a beaker.
(iv)	Crucible	Used for heating substances to high temperatures.

(b) The diagram below represents an experimental set up for the laboratory preparation of dry chlorine gas.

(i) Give the name of each apparatus labelled E, F, and G.

E – Delivery tube
F – Drying tower (containing drying agent)
G – Gas jar for collecting chlorine gas

(ii) Name and state the functions of compounds N and O.

N – Manganese(IV) oxide (MnO_2), acts as a catalyst in the reaction.
O – Concentrated sulfuric acid (H_2SO_4), used as a drying agent to remove moisture from chlorine gas.

(c) (i) Write a balanced chemical equation which represents a reaction between compound M and concentrated hydrochloric acid.

$MnO_2(s) + 4HCl(aq) \rightarrow MnCl_2(aq) + Cl_2(g) + 2H_2O(l)$

(ii) Explain why the above experiment should be conducted in the fume chamber.

Chlorine gas is toxic and irritates the respiratory system. The fume chamber ensures that any released chlorine gas is safely removed from the laboratory environment.

(iii) Why is the gas collected by downward delivery?

Chlorine gas is denser than air, so it is collected by downward delivery to prevent it from escaping.

2. In a certain volumetric analysis experiment, 4.9 g/dm^3 of sulfuric acid was titrated against 20 cm^3 sodium hydroxide solution. The results of the experiment were recorded as shown in Table 1.

Table 1:

Experiment	Pilot	1	2	3	4
Final reading (cm^3)	20.40	40.40	20.00	40.00	20.80
Initial reading (cm^3)	0.00	20.10	0.00	19.90	0.00
Volume used (cm^3)	20.40	20.30	20.00	20.10	20.80

(a) Complete Table 1 by filling in the blank columns.

The completed table is shown above.

(b)(i) Inspect the volume used and identify two readings which had errors.

The readings for Experiment 1 (20.40 cm^3) and Experiment 4 (20.80 cm^3) appear to have errors, as they deviate from the average values.

(ii) Use the correct titre values to find the mean titre volume.

Mean titre volume = (20.30 + 20.00 + 20.10) / 3 = 20.13 cm^3

(c) Write a balanced chemical equation for the reaction which took place.

$H_2SO_4(aq) + 2NaOH(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$

(d)(i) Calculate molarity of the acid solution.

Given mass concentration of H_2SO_4 = 4.9 g/dm^3
Molar mass of H_2SO_4 = (2 × 1) + (32) + (4 × 16) = 98 g/mol
Molarity = 4.9 g/dm^3 ÷ 98 g/mol = 0.05 M

(ii) Find concentration of base in mol/dm^3 and g/dm^3.

From the balanced equation, 1 mole of H_2SO_4 reacts with 2 moles of NaOH.

Moles of H_2SO_4 in titre volume = 0.05 M × (20.13 cm^3 / 1000) = 0.001007 moles
Moles of NaOH = 2 × 0.001007 = 0.002014 moles
Concentration of NaOH = 0.002014 moles / (20 cm^3 / 1000) = 0.1007 M

Mass concentration of NaOH = 0.1007 × 40 = 4.03 g/dm^3

3. Consider the following electrolytic cell:

(a) Name the electrode where:

(i) Oxidation occurs.
Anode

(ii) Reduction occurs.
Cathode

(b) Write down the half-reaction equation occurring at:

(i) Cathode.
$Na^+(l) + e^- \text{----> } Na(s)$

(ii) Anode.
$2Cl^-(l) \text{--->} Cl_2(g) + 2e^-$

(c) If a steady current of 100 amperes flows for 20 minutes through a molten sodium chloride solution, calculate:

(i) The mass of sodium metal deposited.

Charge (Q) = It = 100 A × (20 × 60) s = 120000 C
Faraday's constant = 96500 C/mol
Moles of electrons = 120000 C ÷ 96500 C/mol = 1.244 moles
Since Na^+ requires 1 mole of electrons to deposit 1 mole of Na,
Moles of Na deposited = 1.244 moles
Mass of Na = 1.244 × 23 = 28.6 g

(ii) The volume of chlorine gas liberated at S.T.P.

Since 2 moles of Cl^- produce 1 mole of Cl_2,
Moles of Cl_2 gas = 1.244 ÷ 2 = 0.622 moles
Volume of Cl_2 at S.T.P = 0.622 × 22.4 = 13.93 dm^3

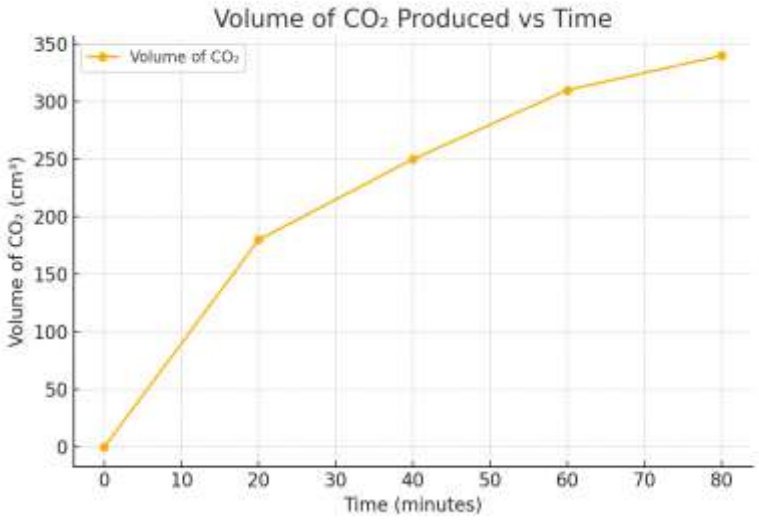
Here is the link to download the graph:

[Graph: Volume of CO_2 Produced vs Time](sandbox:/mnt/data/CO2_vs_time.png)

Now, answering the questions:

4. 5 grams of calcium carbonate were mixed with 250 cm^3 of 0.125M hydrochloric acid solution. The carbon dioxide evolved was collected, measured, and corrected to s.t.p. Measurements were taken after every twenty minutes, and the results were recorded as shown in Table 2.

(a) Draw a graph of time against the volume of carbon dioxide.



(b) Write a balanced chemical equation for the reaction.

$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$

(c) Calculate the mass of calcium carbonate consumed in this process.

From the reaction equation, 1 mole of $CaCO_3$ produces 1 mole of CO_2.
Volume of CO_2 produced = 340 cm^3 = 0.340 dm^3
At s.t.p, 1 mole of gas occupies 22.4 dm^3.

Moles of CO_2 = 0.340 dm^3 / 22.4 dm^3/mol
= 0.01518 moles

Since 1 mole of $CaCO_3$ produces 1 mole of CO_2, moles of $CaCO_3$ used = 0.01518 moles.

Molar mass of $CaCO_3$ = 40 + 12 + (3 × 16) = 100 g/mol.
Mass of $CaCO_3$ consumed = 0.01518 × 100
= 1.518 g

5. Substance CA contains one cation and one anion. Use the information given under the experiment and inference columns in Table 3 to complete the observation column and hence identify substance CA.

S/n	Experiment	Observation	Inferences
(a)	Action of heat on solid CA.	A gas with a choking smell was produced. The residue was yellow when hot and white when cold.	Indicates the presence of SO_2 gas. Probably SO_4^{2-} or SO_3^{2-} may be present. Residue indicates the presence of Zn^{2+}.
(b) (i)	Dissolution of CA.	A colourless solution was formed.	CA indicated as a soluble salt. $Cu(NO_3)_2$, $ZnSO_4$, $Fe(NO_3)_3$ may be present.
(b) (ii)	Action of sodium hydroxide on solution of CA.	A white precipitate was formed, which remained insoluble in excess NaOH.	Probably Zn^{2+} or Pb^{2+} may be present.
(b) (iii)	Action of ammonia solution on solution of CA.	A white precipitate was formed, which dissolved in excess NH_3 forming a colourless solution.	Zn^{2+} may be present.
(b) (iv)	To a solution of CA, dilute HCl is added followed by $BaCl_2$ solution.	A white precipitate was formed.	SO_4^{2-} present and confirmed.
(b) (v)	To a solution of CA, potassium ferrocyanide solution is added in excess.	A white precipitate was formed.	Zn^{2+} present and confirmed.

Conclusion:

(i) The cation in sample CA is Zn^{2+}.

(ii) The anion in the sample CA is SO_4^{2-}.

(iii) The chemical formula for sample CA is $ZnSO_4$.