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: 2007**

Instructions

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

2. Each question carries 10 marks

1. (a) In each case state the reasons for installing in the laboratory the following:

(i) Fire extinguisher.
To control and extinguish accidental fires that may occur due to the presence of flammable substances.

(ii) Fume chamber.
To remove toxic and harmful gases or fumes generated during chemical reactions, ensuring a safe working environment.

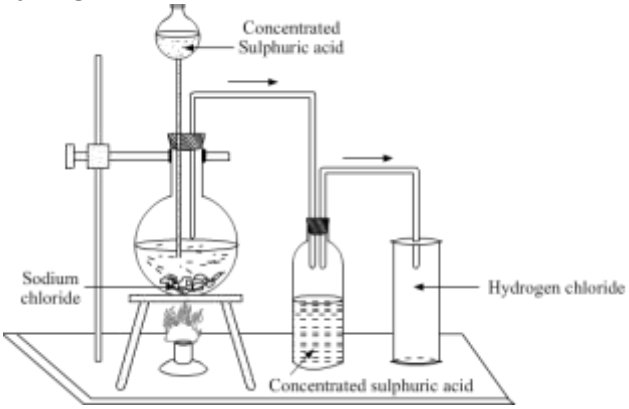
(iii) First aid kit.
To provide immediate medical assistance in case of accidents, burns, cuts, or chemical spills on the skin.

(iv) Chemical balances.
To measure the precise mass of substances required for experiments, ensuring accuracy in laboratory work.

(b) Study the grouped parts of the apparatus connection arranged as A, B, and C shown in figure 1 below, then answer the questions that follow.

(c) (i) Which group of arrangement of apparatus, A, B, or C is not correct? Give reasons for your answer.
Apparatus group C is not correct. The gas produced should be collected in a dry environment rather than in water, as hydrogen chloride is highly soluble in water and would dissolve instead of being collected as a gas.

(ii) Draw the correct arrangement of apparatus for the collection of hydrogen chloride gas.
The correct setup should include a reaction flask with sodium chloride and concentrated sulfuric acid, a delivery tube leading to a gas jar placed upside down to collect the gas by upward displacement of air since hydrogen chloride is denser than air.



(iii) What is the function of concentrated sulfuric acid in the experiment?
Concentrated sulfuric acid acts as a dehydrating agent and reacts with sodium chloride to produce hydrogen chloride gas.

2. In an experiment, 0.1 M HCl was titrated against hydrated sodium carbonate ($Na_2CO_3 \cdot xH_2O$) solution of concentration 14.3 g/dm³. The volume of pipette used was 20 cm³, and the burette readings were recorded as shown in Table 1 below.

Burette readings

Experiment	Pilot	1	2
Final reading (cm³)	22.00	40.90	21.95
Initial reading (cm³)	01.00	21.00	02.00
Titre volume (cm³)	21.00	19.90	19.95

(a) Complete the table by filling in the values of titre volume in each column.
Values have been completed in the table above.

(b) Calculate the mean titre volume.
Mean titre volume = (21.00 + 19.90 + 19.95) / 3
= 20.28 cm³

(c) Write a balanced chemical equation for the reaction, which took place during the titration of sodium carbonate solution and hydrochloric acid.
$Na_2CO_3 + 2HCl \text{ ----> } 2NaCl + CO_2 + H_2O$

(d) Calculate the:

(i) Molarity of sodium carbonate.
Using the equation:
$M_1V_1 = nM_2V_2$
where:
M_1 = molarity of Na_2CO_3
$V_1 = 20$ cm³
n = 1 (from balanced equation)
$M_2 = 0.1$ M (HCl)
$V_2 = 20.28$ cm³ / 1000

$M_1 = (0.1 \times 20.28) / (2 \times 20)$
$M_1 = 0.0507$ M

(ii) Concentration in g/dm³ of sodium carbonate.
Concentration = molarity × molar mass
Molar mass of $Na_2CO_3 = 106$ g/mol

Concentration = 0.0507 × 106

= 5.38 g/dm³

(iii) Number of water of crystallization, x in $Na_2CO_3 \cdot xH_2O$.
Given concentration of hydrated sodium carbonate = 14.3 g/dm³
Molar mass of $Na_2CO_3 \cdot xH_2O$ = 106 + 18x

0.0507 × (106 + 18x) = 14.3
5.38 + 0.91x = 14.3
0.91x = 8.92
x = 9.8 ≈ 10
Thus, the formula is $Na_2CO_3 \cdot 10H_2O$, meaning x = 10.

3. The diagram in figure 2 below represents the electrolysis of dilute sulfuric acid.

(a) Name gases x and y.
Gas x is oxygen, and gas y is hydrogen.

(b) Write the equations of discharging reactions, which took place at the
(i) anode
$4OH^- \text{---> } O_2 + 2H_2O + 4e^-$
(ii) cathode
$2H^+ + 2e^- \text{----> } H_2$

(c) What is the name of the apparatus used in the experiment of the electrolysis of dilute sulfuric acid represented by the diagram in figure 2 above?
The apparatus used is called a Hofmann voltameter.

(d) An electric current was passed through two voltameters connected in series whose electrolytes were calcium chloride and copper (II) sulfate solutions, respectively. Carbon rods were used as electrodes in both voltameters. Calculate the mass of copper produced if 3.2 g of chlorine were produced at standard temperature and pressure.
Using the equation:
$Cl_2 + 2e^- \text{----> } 2Cl^-$

Molar mass of Cl_2 = 71 g/mol
Moles of Cl_2 produced = 3.2 / 71
= 0.0451 mol

From Faraday's laws, the ratio of moles of Cl_2 to Cu deposited is 1:1, meaning the same moles of Cu are deposited.
Molar mass of Cu = 63.5 g/mol
Mass of Cu deposited = 0.0451 × 63.5
= 2.86 g

4. The study of the rate of evolution of hydrogen from magnesium ribbon of uniform width with excess dilute hydrochloric acid was done in a certain school laboratory. The results obtained were recorded as shown in the table below.

Length of magnesium ribbon (cm)	1.0	2.0	3.0	4.0	5.0	6.0	7.0
Rate of evolution of hydrogen (cm^3/min)	1.1	2.0	2.9	3.8	4.8	5.6	6.6

(a) Write the equation of reaction between magnesium ribbon and dilute hydrochloric acid.
$Mg + 2HCl \rightarrow MgCl_2 + H_2$

(b) Why was excess hydrochloric acid used in the experiment?
To ensure that all the magnesium reacts completely and that the rate of reaction is only dependent on the amount of magnesium present.

(c) How did the rate of evolution of hydrogen gas vary with the length of magnesium ribbon?
The rate of evolution of hydrogen gas increased as the length of magnesium ribbon increased.

(d) What would be the effect on the rate of evolution of hydrogen if:
(i) the temperature was increased?
The rate would increase due to higher kinetic energy of reacting particles.

(ii) magnesium powder was used?
The rate would increase because of the larger surface area available for reaction.

(iii) a catalyst was used?
The rate would increase as the activation energy would be lowered.

(iv) a more diluted hydrochloric acid was used?
The rate would decrease due to a lower concentration of hydrogen ions.

5. Use the information given under the experiment and inference columns in table 2 below to complete the observation column.

Experiment	Observation	Inferences
(a) Appearance of sample Z	Solid with metallic luster	Probably Pb^{2+} or Cu^{2+} present.
(b) To a portion of solid Z in a test tube, concentrated sulfuric acid was added and the gas given off was tested.	White fumes produced	Cl^- present.
(c) To another portion of Z in a test tube, MnO_2 was added followed by concentrated H_2SO_4. The gas evolved was passed over moist litmus paper.	Greenish yellow gas evolved turning blue litmus red	Cl^- confirmed.
(d) Sample Z was dissolved in distilled water.	Blue solution formed	Soluble salts of Cu^{2+} suspected.

| (e) Excess sodium hydroxide solution was added to the solution of sample Z and heated. | Blue precipitate formed, turning black on heating | Residue is CuO, thus Cu^{2+} is present. |
| (f) Ammonium hydroxide solution was added to a solution of Z until excess. | Deep blue solution formed | Cu^{2+} confirmed. |

Conclusion
The cation in sample Z is Cu^{2+} and the anion is Cl^{-}.