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: 2001**

Instructions

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

2. Each question carries 10 marks

1. The diagram below represents laboratory preparation of oxygen.

(a) Give the names of the apparatuses labeled A to G.
A - Test tube
B - Delivery tube
C - Clamp
D - Bunsen burner
E - Water trough
F - Gas jar
G - Water

(b) What is the function of MnO_2 in this experiment?
MnO_2 acts as a catalyst that speeds up the decomposition of potassium chlorate ($KClO_3$) to produce oxygen gas without being consumed in the reaction.

(c) Why is the preparation of oxygen done by water displacement and not by air displacement? Give two reasons.
Oxygen is slightly soluble in water, so it can be collected without significant loss.
Oxygen is less dense than air, so air displacement would lead to contamination with atmospheric gases.

2. A student titrated 25.00 mls of sodium hydroxide solution against 0.05 M succinic acid ($CH_2(COOH)_2$). The volume of the pipette was 25 cm^3. Succinic acid is a weak organic acid. The student obtained the following data.

Experiment	Final reading (cm^3)	Initial reading (cm^3)	Titre volume (cm^3)
Pilot	24.70	1.00	23.70
1	43.60	20.00	23.60
2	33.60	10.00	23.60

(a) Complete the table above.
Completed as shown in the table.

(b) Calculate the average volume of the acid used.
Average volume = (23.70 + 23.60 + 23.60) / 3 = 23.63 cm^3

(c) If the acid reacted with the alkali according to the equation:
$(CH_2)(COOH)_2 + 2NaOH \rightarrow (CH_2)_2(COONa)_2 + 2H_2O$

(i) Calculate the molarity of the alkali.
Moles of acid used = Molarity × Volume (in dm^3)

= 0.05 × (23.63/1000)
= 0.0011815 moles

Since 1 mole of succinic acid reacts with 2 moles of NaOH,
Moles of NaOH = 0.0011815 × 2 = 0.002363 moles

Molarity of NaOH = moles/volume
= 0.002363 / (25/1000)
= 0.0945 mol/dm³

(ii) Calculate the concentration in g/dm³ of the alkali.
Molar mass of NaOH = 40 g/mol
Mass = 0.0945 × 40 = 3.78 g/dm³

(d) Name a suitable indicator for this titration.
Phenolphthalein.

3. 0.1 Mole of Metal M in a lump form was added to 60 cm³ of 0.5 M sulphuric acid. The rate of reaction was measured by timing the evolution of hydrogen gas. The experiment was repeated by using 0.1 mole of the same metal in powder form and 60 cm³ of 0.5 M sulphuric acid.

Amount of Metal M (Moles)	Volume of Sulphuric Acid (cm³)	Rate of evolution of Hydrogen ($x10^{-3}$ mol/sec)
Lump 0.1	60	3.6
Powder 0.1	60	12.7

(a) Explain four factors which affect the rate of a chemical reaction.
Surface area - Smaller particles or powders react faster due to increased contact with reactants.
Temperature - Higher temperature increases particle energy, leading to more collisions and faster reactions.
Concentration - Higher concentration increases reaction speed by providing more reactant particles.
Catalyst - A catalyst lowers activation energy, speeding up the reaction without being consumed.

(b) (i) Which factor affected the rate of evolution of hydrogen from the reaction of metal M and sulphuric acid?
Surface area, as powdered metal has a larger surface area than a lump, increasing reaction speed.

(ii) How many moles of H_2SO_4 are present in 60 cm³ of 5 M H_2SO_4 solution?
Moles = Molarity × Volume (in dm³)
= 5 × (60/1000)
= 0.3 moles

(iii) Calculate the volume of hydrogen gas evolved at S.T.P. when excess of M is mixed with 0.3 mole of H_2SO_4 solution.

From the reaction equation, 1 mole of H_2SO_4 produces 1 mole of H_2 gas.
So, 0.3 moles of H_2SO_4 produce 0.3 moles of H_2 gas.

Volume of H_2 at S.T.P. = Moles × Molar gas volume (22.4 dm^3)
= 0.3 × 22.4
= 6.72 dm^3 or 6720 cm^3

4. Dilute copper(II) sulfate was electrolyzed using copper electrodes as an attempt to verify Faraday's first law of electrolysis. The mass of metal deposited at the cathode was taken at constant intervals of 900 seconds.

Experiment	Current I (A)	Time (s)	Mass of Copper Deposited (g)	Quantity of Electricity Q (C)	Electrochemical Equivalent Z (g C^{-1})
1	0.2	900	0.063	180	0.00035
2	0.2	1800	0.129	360	0.00036
3	0.2	2700	0.187	540	0.00035
4	0.2	3600	0.260	720	0.00036

(a) Complete the table above by calculating

(i) The quantity of electricity passed in experiment 1, 2, 3, and 4
Q = Current × Time
For experiment 1: Q = 0.2 × 900 = 180 C
For experiment 2: Q = 0.2 × 1800 = 360 C
For experiment 3: Q = 0.2 × 2700 = 540 C
For experiment 4: Q = 0.2 × 3600 = 720 C

(ii) The electrochemical equivalent Z of copper in experiment 1, 2, 3, and 4
Z = Mass deposited / Quantity of electricity
For experiment 1: Z = 0.063 / 180 = 0.00035 g C^{-1}
For experiment 2: Z = 0.129 / 360 = 0.00036 g C^{-1}
For experiment 3: Z = 0.187 / 540 = 0.00035 g C^{-1}
For experiment 4: Z = 0.260 / 720 = 0.00036 g C^{-1}

(b) Which substance will be deposited at the

(i) Cathode
Copper (Cu)

(ii) Anode
Copper dissolves as Cu^{2+} ions into the solution.

5. Sample Q contains one anion and one cation. A list of experiments was done to identify the cation and anion. Use the observations made from the experiments to give the correct conclusion and then identify the cation and anion present in the sample.

Experiment	Observation	Inference
(a) Appearance	White crystalline salt	The salt is an ionic compound.

| (b) A little solid Q was heated in a dry test tube | White sublimate, brown fumes evolved, a gas which relights a glowing splint was evolved | The presence of ammonium and nitrate ions (NH_4^+ and NO_3^-) is indicated. |

| (c) To a little Q in a test tube, distilled water was added and stirred | Colourless solution was formed | The salt is soluble in water. |

| (d) To solid Q in a test tube, conc. H_2SO_4 was added | Brown fumes evolved | Presence of nitrate (NO_3^-) ions confirmed as they decompose to NO_2 gas. |

| (e) To aqueous solution of Q in a test tube, freshly prepared iron(II) sulfate solution was added followed by conc. H_2SO_4 slowly along the sides of the test tube | A brown ring formed between the two liquids | Confirms the presence of nitrate (NO_3^-) ions (Brown ring test). |

| (f) To aqueous solution Q in a test tube, NaOH(aq) was added and boiled | A gas with a pungent smell evolved which turned moist red litmus paper blue | Confirms the presence of ammonium (NH_4^+) ions. |

The cation was ammonium (NH_4^+) and the anion was nitrate (NO_3^-).

The compound was ammonium nitrate (NH_4NO_3).