THE UNITED REPUBLIC OF TANZANIA
NATIONAL EXAMINATIONS COUNCIL OF TANZANIA
DIPLOMA IN SECONDARY EDUCATION EXAMINATION

732/2A **CHEMISTRY 2A**

(ACTUAL PRACTICAL A)

Time: 3 Hours **ANSWERS** **Year: 2017**

Instructions.

1. This paper consists of **three (3)** questions.
2. Answer **all** questions
3. Question number 1 carries 20 marks and the rest carry 30 marks.
4. Cellular phones are **note** allowed in the examination room.
5. Write your **examination Number** on every page of your answer booklet(s).

1. You are provided with the following:

Solution A: 0.05 M sodium hydroxide solution

Solution B: A diprotic acid H_2X of unknown concentration

Phenolphthalein indicator

(a) Pipette 25.0 cm^3 of solution B into a clean conical flask. Add 2–3 drops of phenolphthalein and titrate against solution A taken in a burette. Repeat the titration to obtain three consistent readings.

Pipette 25.0 cm^3 of solution B was transferred into a conical flask. Two to three drops of phenolphthalein were added. Sodium hydroxide solution (A) was placed in the burette and titrated against B. The process was repeated to get three concordant readings.

(b) Record the initial and final burette readings for each titration in a well-labeled table and calculate the volume of solution A used.

Titration Number	**Final Burette Reading (cm^3)**	**Initial Burette Reading (cm^3)**	**Volume Used (cm^3)**
1	24.8	0.0	24.8
2	24.6	0.0	24.6
3	24.7	0.0	24.7

(c) Determine the average volume of solution A used in the titration.

Average volume = (24.8 + 24.6 + 24.7) ÷ 3

Average volume = 74.1 ÷ 3 = **24.7 cm^3**

(d) Write a balanced chemical equation for the neutralization reaction.

$H_2X + 2NaOH \rightarrow Na_2X + 2H_2O$

(e) Calculate the number of moles of sodium hydroxide used in the average titration.

Moles of NaOH = molarity × volume in dm^3

= 0.05 mol/dm^3 × (24.7 ÷ 1000) dm^3

= 0.05 × 0.0247 = **0.001235 mol**

(f) Using your results, calculate the concentration of solution B in mol/dm^3.

From the balanced equation:

1 mol of H_2X reacts with 2 mol of NaOH

Moles of H_2X = 0.001235 ÷ 2 = **0.0006175 mol**

Volume of B used = 25.0 cm^3 = 0.025 dm^3

Concentration of B = moles ÷ volume

= 0.0006175 ÷ 0.025 = **0.0247 mol/dm^3**

(g) If 1.89 g of acid H_2X was used to prepare 250 cm^3 of solution B, calculate the molar mass of the acid.

Volume = 250 cm^3 = 0.25 dm^3

Number of moles in 0.25 dm^3 = concentration × volume

= 0.0247 × 0.25 = **0.006175 mol**

Molar mass = mass ÷ moles = 1.89 ÷ 0.006175 = **306 g/mol**

(h) Identify the likely element X in H_2X if it is a common inorganic element.

Since the molar mass of H_2X is 306 g/mol and two hydrogens contribute 2 g/mol,

X = 306 − 2 = 304 g/mol.

This suggests X is likely a polyatomic group rather than a single element.

However, such high molar mass hints X may represent a benzenedicarboxylic acid derivative (e.g. phthalic acid).

Thus, X is likely an organic radical from a common dicarboxylic acid.

2. You are provided with:

T1: Sodium thiosulphate solution (20 g/dm^3)

T2: Dilute hydrochloric acid (1.0 M)

T3: Distilled water

A stopwatch, a white paper marked "X", and other necessary materials

(a) Place the paper marked "X" on the bench and put a clean 50 cm^3 beaker on top. Mix volumes of T1 and T3 as shown below. Then quickly add 10 cm^3 of T2, start the stopwatch immediately and record the time taken for the mark "X" to disappear.

Experiment	Volume of T1 (cm^3)	Volume of T3 (cm^3)	Volume of T2 (cm^3)
1	2	8	10
2	4	6	10
3	6	4	10
4	8	2	10

The experiments were carried out as described. The times recorded and rates calculated are shown below.

(i) Record the time taken for the cross to disappear in each case.

Experiment	Time, t (sec)
1	370
2	180
3	95
4	50

(ii) Complete the table by calculating the rate of reaction using 1/t for each experiment.

Experiment	t (s)	1/t (s^{-1})
1	370	0.00270
2	180	0.00556
3	95	0.01053
4	50	0.02000

(iii) Plot a graph of rate of reaction (1/t) against volume of T1 used.

(iv) Describe the shape of your graph and what it suggests about the relationship between rate and concentration.

The graph is a straight line passing through the origin, indicating that the rate of reaction increases linearly with the volume (concentration) of sodium thiosulphate. This shows a direct proportionality.

(v) State the order of the reaction with respect to sodium thiosulphate.

Since the graph is linear and passes through the origin, the reaction is **first-order** with respect to sodium thiosulphate.

(vi) Write the balanced ionic equation for the reaction that takes place.

$S_2O_3^{2-}(aq) + 2H^+(aq) \rightarrow SO_2(g) + S(s) + H_2O(l)$

(vii) State the name of the substance responsible for the cloudiness during the reaction.

The cloudiness is caused by the **precipitate of sulphur (S)** formed during the reaction.

(viii) Suggest one way the experiment can be improved to determine the order with respect to hydrochloric acid.

To determine the order with respect to HCl, repeat the experiment while **varying the volume of T2** (HCl) and keeping the volume of T1 constant.

3. You are provided with a white crystalline solid labeled Sample W. Carry out the following tests and record your observations and inferences.

(a) Observe the physical appearance of the sample.

Observation: White crystalline solid

Inference: Likely a salt

(b) Test the solubility of the sample in cold water.

Observation: Dissolves completely

Inference: Soluble salt

(c) Add a few drops of dilute hydrochloric acid to a small portion of W in a test tube.

Observation: Effervescence; gas turns limewater milky

Inference: CO_3^{2-} ion present

(d) Add concentrated sulphuric acid to a fresh portion of W.

Observation: Vigorous effervescence; gas turns limewater milky

Inference: Confirm presence of carbonate ion (CO_3^{2-})

(e) Perform a flame test using a platinum wire dipped in the solid.

Observation: Yellow flame

Inference: Sodium ion (Na^+) present

(f) To a small amount of W, add aqueous sodium hydroxide dropwise and then in excess.

Observation: No precipitate

Inference: Confirms Na^+ ion

(g) To another portion, add aqueous ammonia dropwise and then in excess.

Observation: No precipitate

Inference: Confirms Na^+ ion

(h) Record your observations and write appropriate inferences in a clearly structured table.

Test	**Observation**	**Inference**
Appearance	White crystalline solid	Possibly a salt
Solubility in cold water	Soluble	Soluble salt
Dil. HCl + sample	Effervescence; CO_2 evolved	CO_3^{2-} present
Conc. H_2SO_4 + sample	Vigorous effervescence	Confirms CO_3^{2-}
Flame test	Yellow flame	Na^+ present
NaOH dropwise and in excess	No precipitate	Confirms Na^+
NH_4OH dropwise and in excess	No precipitate	Confirms Na^+

(i) Identify the cation and the anion present in Sample W.

Cation: Sodium ion (Na^+)

Anion: Carbonate ion (CO_3^{2-})

(j) Write two balanced chemical equations to support your identification of the ions present.

$Na_2CO_3(s) + 2HCl(aq) \rightarrow 2NaCl(aq) + CO_2(g) + H_2O(l)$

$Na_2CO_3(s) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + CO_2(g) + H_2O(l)$