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

732/2B **CHEMISTRY 2B**

(ACTUAL PRACTICAL B)

Time: 3 Hours **ANSWERS** **Year: 2023**

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. Sulphuric acid is hygroscopic and is an oxidizing agent; its concentration cannot be stable for a long time. You have decided to prove this fact by conducting an experiment using sulphuric acid solution labelled SA and primary standard solution made by dissolving 0.840 g of anhydrous sodium hydrogen carbonate in exactly 100 mL of solution. The primary standard solution was labelled PS. The titration indicator is methyl orange solution. Perform the experiment in the given procedures and answer the questions that follow.

Procedure

(i) Pipette 20 cm^3 or 25 cm^3 of the solution PS and transfer it into the titrating flask.

(ii) Add 2 to 3 drops of the indicator (MO) in the titrating flask.

(iii) Transfer SA solution into the burette.

(iv) Titrate PS using SA until the end point is reached.

(v) Repeat step (i) to (iv) three more times.

Questions

(a) (i) What is the volume of pipette used?

The volume of the pipette used is **25.0 cm^3**, since it is the common standard volume for titration and is explicitly stated as one of the options.

(ii) Draw and complete appropriate table of results.

Titration No.	**Final burette reading (cm^3)**	**Initial burette reading (cm^3)**	**Volume used (cm^3)**
Rough	25.30	0.00	25.30
1st	25.20	0.00	25.20
2nd	25.10	0.00	25.10
3rd	25.20	0.00	25.20

(b) (i) Calculate the average volume of SA used.

Average volume = (25.20 + 25.10 + 25.20) ÷ 3 = **25.17 cm^3**

(ii) Calculate the molarity of sodium hydrogen carbonate in solution PS.

Molar mass of $NaHCO_3$ = 23 + 1 + 12 + (16 × 3) = **84 g/mol**

Mass = 0.840 g, Volume = 100 mL = 0.1 dm^3

Moles = 0.840 ÷ 84 = 0.01 mol

Molarity = 0.01 mol ÷ 0.1 dm^3 = **0.1 mol/dm^3**

(c) (i) Write the balanced chemical equation for the reaction that took place in this experiment.

H_2SO_4 (aq) + $2NaHCO_3$ (aq) → Na_2SO_4 (aq) + $2CO_2$ (g) + $2H_2O$ (l)

(ii) Calculate the molarity of the standardized sulphuric acid.

From the equation: 1 mol H_2SO_4 reacts with 2 mol $NaHCO_3$

Moles of $NaHCO_3$ = 0.1 mol/dm³ × 25.0 cm³ ÷ 1000 = 0.0025 mol

So, moles of H_2SO_4 = 0.0025 ÷ 2 = 0.00125 mol

Volume of SA used = 25.17 cm³ = 0.02517 dm³

Molarity of SA = 0.00125 ÷ 0.02517 ≈ **0.0497 mol/dm³**

2. You are given a task to determine the effect of temperature on the rate of chemical reaction using sodium thiosulphate and nitric acid. During the experiment, you observe that sodium thiosulphate reacts with an acid to form white precipitates. However, the intensity of precipitation changes with change in temperature. You are asked to replicate the same experiment by using the following materials:

B1: A solution of 0.05 M sodium thiosulphate

B2: A solution of 0.1 M nitric acid

Stopwatch, thermometer and other relevant facilities

Perform the experiment through the given procedures and then answer the questions that follow.

Procedures

(i) Put an empty beaker (50 cm³) on top of the mark "+" drawn on the given piece of paper. Make sure that the mark is clearly visible.

(ii) Pour about 200 cm³ of water into a 250 or 300 cm³ beaker. (Use this as your water bath).

(iii) Measure 10 cm³ of B1 and 10 cm³ of B2, and pour into separate test tubes.

(iv) Put the two test tubes containing B1 and B2 into the water bath and warm the contents to 50 °C.

(v) Pour the hot solutions of B1 and B2 in the beaker in (i) and immediately start the stopwatch.

(vi) Using a glass rod, stir the reaction mixture and record the time taken for the letter + to disappear completely.

(vii) Repeat the procedure (iii) to (vi) by warming to temperatures, 60 °C, 70 °C and 80 °C instead of warming to 50 °C in procedure (iv).

Questions

(a) Complete the following Table

Temperature (°C)	**Temperature (K)**	**Time, t (s)**	**Rate (1/t) (s^{-1})**	**log(1/t)**
50	323	36	0.0278	-1.556
60	333	22	0.0455	-1.342
70	343	14	0.0714	-1.146
80	353	9	0.1111	-0.954

(b) From the table of results, give a conclusion with respect to the relationship between the temperature and the rate of reaction.

As temperature increases, the time taken for the reaction to complete decreases, and the rate of reaction (1/t) increases. Therefore, **the rate of reaction increases with increasing temperature**. This is because higher temperature increases the kinetic energy of particles, leading to more frequent and more energetic collisions.

(c) Plot a graph of log(1/t) as a function of 1/T.

Plot log(1/t) on the y-axis

Plot 1/T (in K^{-1}) on the x-axis

Temperature (K)	1/T (K^{-1})	log(1/t)
323	0.00310	-1.556
333	0.00300	-1.342
343	0.00292	-1.146
353	0.00283	-0.954

Use these values to draw a straight-line graph. It should slope downward.

(i) Arrhenius equation can be presented by the relation:

log(1/t) = -Ea / (2.303RT) + logA

This fits the straight-line form: y = mx + c, where:

- y = log(1/t)
- x = 1/T
- m = -Ea / 2.303R

So, the slope m = Δy / Δx = (−0.954 − (−1.556)) / (0.00283 − 0.00310) = 0.602 / (−0.00027) = **−2229.6**

Now, use the slope to calculate activation energy (Ea):

Slope = −Ea / 2.303R

R = 8.314 J/mol·K

Ea = −slope × 2.303 × R

Ea = 2229.6 × 2.303 × 8.314 ≈ **42612.5 J/mol ≈ 42.6 kJ/mol**

3. John was complaining of stomach pains after drinking some tea. After diagnosis by the medical doctor, it was noted that the tea might have been contaminated with sample L. Perform the experiment to identify the cation and anion present in the tea sample based on the following tests and answer the questions that follow:

(i) Appearance of sample L

(ii) Action of heat on sample L in a test tube

(iii) Action of dilute sulphuric or hydrochloric acid to solid sample

(iv) Action of concentrated sulphuric acid on solid sample

(v) Flame test

(vi) Solubility of the sample

(vii) Confirmatory test for the anion

(viii) Confirmatory test for the cation

Questions

(a) Prepare a relevant Table showing the qualitative analysis results.

Test	Observation	Inference
(i) Appearance	White crystalline powder	Ionic salt likely present
(ii) Action of heat	No water droplets; white solid turns yellow when hot	Possible lead or zinc salt
(iii) Dilute acid on solid	Effervescence observed	CO_3^{2-} (carbonate) likely
(iv) Conc. H_2SO_4 on solid	Effervescence, white fumes observed	Confirms presence of CO_3^{2-}
(v) Flame test	Brick red flame	Confirms Ca^{2+} (calcium ion)
(vi) Solubility	Soluble in water	Confirms ionic nature
(vii) Confirmatory test for anion (lime water test)	Lime water turns milky	CO_2 evolved → CO_3^{2-} present
(viii) Confirmatory test for cation (NaOH or flame)	White precipitate with NaOH, brick red flame	Confirms Ca^{2+}

(b) Identify the ions in sample L.

The **cation** present is **Ca^{2+} (calcium ion)**

The **anion** present is **CO_3^{2-} (carbonate ion)**

(c) What is the name of sample L?

Sample L is **calcium carbonate ($CaCO_3$)**

(d) Write the reaction equation to indicate what took place in test (viii).

$Ca^{2+}(aq) + 2OH^-(aq) \rightarrow Ca(OH)_2(s)$

(e) Write the reaction equation to indicate what took place in test (iv).

$CaCO_3$ (s) + H_2SO_4 (conc.) → $CaSO_4$ (s) + CO_2 (g) + H_2O (l)