THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL

ADVANCED CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

132/3C **CHEMISTRY 3C**

ACTUAL PRACTICAL C

(For Both School and Private Candidates)

Duration: 3:20 Hours **ANSWERS** **Year: 2025**

Instructions

1. This paper consists of **three (3)** questions.
2. Answer **all** questions.
3. Question **one (1)** carries 20 marks and the other **two (2)**, carry 15 marks each.
4. Qualitative Analysis Guide (QAG) sheet authorised by NECTA may be used
5. Mathematical tables and non programmable calculators may be used.
6. Communication devices and any unauthorised materials are **not** allowed in the examination room.
7. Write your **Examination Number** on every page of your answer booklet(s).
8. You may use the following constants:
   - Atomic masses: H = 1, C = 12, O = 16, S = 32, Na = 23, Cl = 35.5, K = 39, Mn = 55
   - Density of water = 1 g/cm^3
   - Specific heat capacity of water = 4.18 $Jg^{-1}K^{-1}$

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1. Use the reagents and apparatus given to demonstrate how you would analyse hydrated $Na_2 S_2 O_3$ to determine the number of molecules of water of crystallisation.

   W1: A solution of 0.08 mole of $KMnO_4$ in 2000 cm^3;

   W2: A solution of $Na_2S_2O_3.XH_2O$ made by dissolving 14.88 g in 600 cm^3 of distilled water;

   W3: A solution of 10% KI;

   W4: A starch solution;

   W5: A solution of 1 M sulphuric acid.

   Theory

   A quantitative reaction between potassium permanganate and potassium iodide in acidic medium leads to the production of iodine. During titration, iodine reacts with sodium thiosulphate in presence of starch which acts as an indicator.

   Procedure

   (i) Fill a burette with **W2**.

   (ii) Measure 10 cm3 of **W1** into a conical flask. Add 10 cm3 of distilled water. Swirl the mixture gently and add 10 cm3 of **W3**. Add 10 cm3 of **W5** into the mixture.

   (iii) Titrate **W2** against the mixture until a pale yellow colour is observed. Add 2 cm^3 of **W4** and continue to titrate until the colour of the solution changes from dark blue to colourless.

   (iv) Record the first titre value.

   (v) Repeat steps (i) to (iv) three times and record the titre values.

Questions

(a) Volume of burette used was 50.00 cm^3

Volume of pipette used was 20.00 cm^3

TABLE OF RESULTS

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Titration number	Pilot	1	2	3
Final volume (cm^3)	20.10	40.30	20.00	39.80
Initial volume (cm^3)	0.00	20.10	0.00	20.00
Volume used (cm^3)	20.10	20.20	20.00	19.80

Average titre volume = (Volume 1 + Volume 2 + Volume 3) / 3

= (20.20 + 20.00 + 19.80) cm^3 / 3

= 60.00 cm^3 / 3

∴ Average titre volume was 20.00 cm^3

(b) (i) From conical flask.

$2MnO_4^- + 10I^- + 16H^+ \rightarrow 2Mn^{2+} + 5I_2 + 8H_2O$

(ii) Reaction between iodine and sodium thiosulphate:

$2S_2O_3^{2-} + I_2 \rightarrow S_4O_6^{2-} + 2I^-$

(c) From dilution law:

McVc = MdVd

Molarity before dilution (Mc) = 0.04 mol/dm^3

Volume before dilution (Vc) = 10.00 cm^3

Molarity after dilution (Md) = Required (?)

Volume after dilution (Vd) = 20.00 cm^3

Mc = number of moles (mol) / Volume (cm^3)

(c)

Volume = 20000 cm^3

1 dm^3 = 1000 cm^3

? = 20000 cm^3

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= 1 dm^3 × 20000 cm^3 / 1000 cm^3

= 2 dm^3

Number of moles = 0.08 mole of $KMnO_4$

Mc = 0.08 moles / 2 dm^3

Mc = 0.04 mol/dm^3

Vd = Vc + volume of distilled water

= 10.00 cm^3 + 10.00 cm^3

Vd = 20.00 cm^3

Md = McVc / Vd

Md = 0.04 mol/dm^3 × 10.00 cm^3 / 20.00 cm^3

∴ Md = 0.02 mol/dm^3

(d) From reactions:

$2MnO_4^- + 10I^- + 16H^+ \rightarrow 2Mn^{2+} + 5I_2 + 8H_2O$

$5S_2O_3^{2-} + I_2 \rightarrow 5S_4O_6^{2-} + 2I^-$

$2MnO_4^- + 10I^- + 16H^+ + 10S_2O_3^{2-} + 5I_2 \rightarrow 2Mn^{2+} + 5I_2 + 8H_2O + 5S_4O_6^{2-} + 10I^-$

∴ **Balanced equation:**

$2MnO_4^- + 16H^+ + 10S_2O_3^{2-} \rightarrow 2Mn^{2+} + 5S_4O_6^{2-} + 8H_2O$

(d)

Molar mass = 24.8 g/dm^3

0.1 mol/dm^3

Molar mass = 248 g/mol

From: $Na_2S_2O_3 \cdot xH_2O$ = 248 g/mol

$Na_2S_2O_3 \cdot xH_2O$ = 248 g/mol

$2(Na) + 2(S) + 3(O) + (H_2O)_x$ = 248 g/mol

158 g/mol + (18×) g/mol = 248 g/mol

(18×) g/mol = 90 g/mol

18 g/mol | 18 g/mol

∴ x = 5

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Percentage composition = (water composition × 100%) / total hydrated $Na_2S_2O_3$

Water composition = $Na_2S_2O_3 \cdot 5H_2O$

= $5H_2O$

= 5(18 g/mol)

= 90 g/mol

Total hydrated $Na_2S_2O_3$ = 248 g/mol

Percentage composition = (90 g/mol × 100%) / 248 g/mol

= 0.3629 × 100%

= 36.29%

∴ Percentage composition of water in $Na_2S_2O_3 \cdot xH_2O$ was 36.29%.

2. Use the following reagents and the given apparatuses to determine the rate constant of the reaction:

R1: Hydrogen peroxide solution;

R2: A solution made by dissolving 7.9 g of sodium thiosulphate in 1 dm3 of distilled water;

R3: A solution made by dissolving 8.3 g of KI per litre in 0.5 M H_2 SO_4;

Starch solution;

Distilled water;

100 cm^3 beakers labelled **I** and **II**;

Stopwatch.

TABLE OF RESULTS

Volume of R1(cm^3)	30	25	20	15	10	5
Volume of distilled water (cm^3)	5	10	15	20	25	30
Time for blue colour to appear (sec)	11.5	17.4	21.4	27.1	43.6	96.4
Rate (1/time) (sec^{-1})	0.09	0.06	0.05	0.04	0.02	0.08

(a) **Consider a graph of (1/t) against volume of H_2.**

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(b) **The order of reaction with respect to H_2 is the first order.**

(c) From,

$R = K [H_2O_2]$

$y = mx$

Slope (m) = K

From the graph,

Slope (m) = Δy (sec^{-1}) / Δx (cm^3)

A (9.25 cm^3, 0.0219 sec^{-1})

B (27.5 cm^3, 0.06424 sec^{-1})

Slope (m) = (0.06424 sec^{-1} - 0.0219 sec^{-1}) / (27.5 cm^3 - 9.25 cm^3)

$= 2.32 \times 10^{-3}\ s^{-1}\ cm^{-3}$

Rate constant (K) = Slope

Therefor the rate constant is $2.32 \times 10^{-3}\ s^{-1}\ cm^{-3}$

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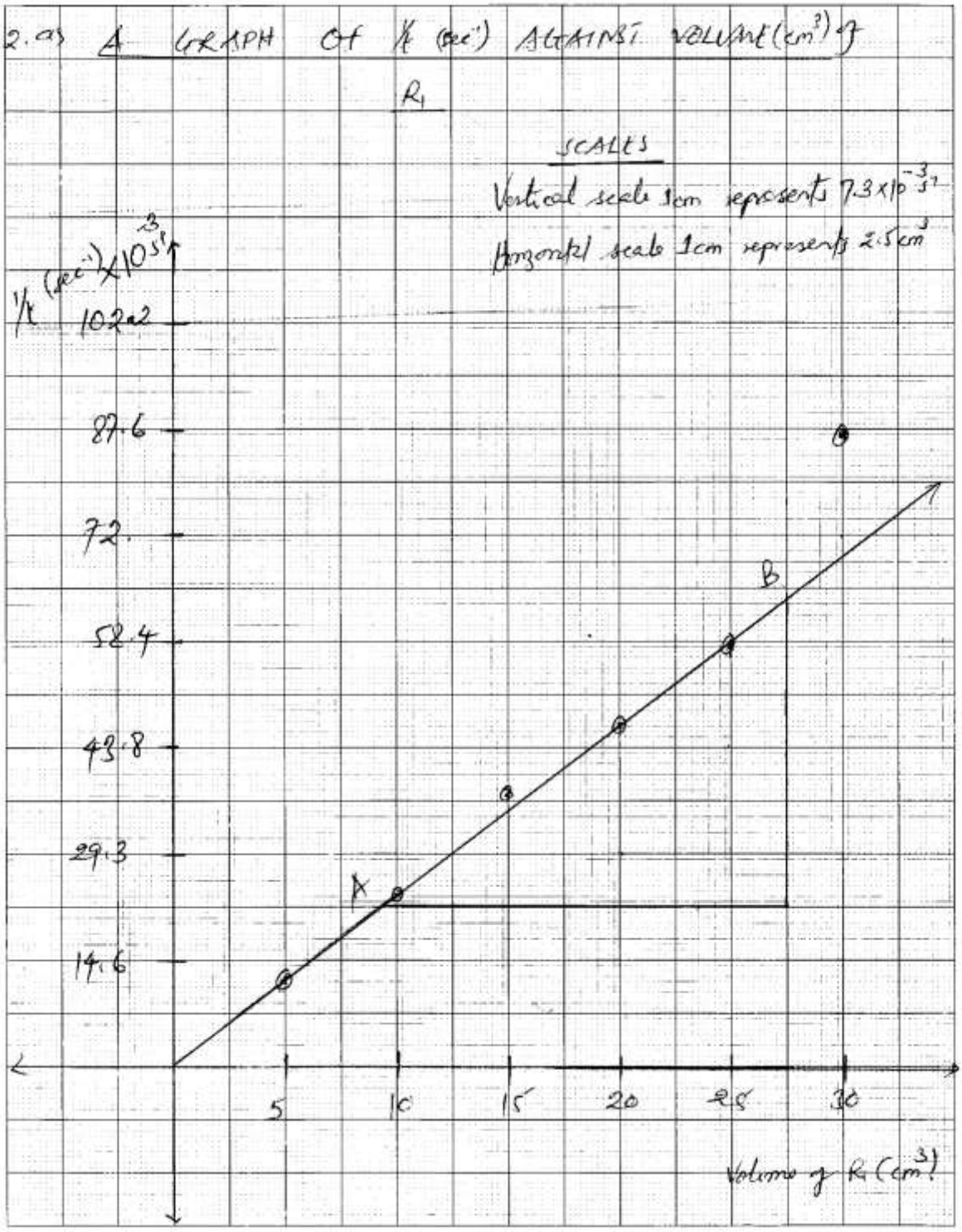

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3. Sample **RV** contains one cation and one anion. Using systematic qualitative analysis procedures analyse the sample. Carefully, record your experiments, observations and inferences as shown in Table 2. Finally, identify the anion and cation present in sample **RV**.

Systematic Qualitative Analysis

Table 2: Experiment Data

S/N	Experiment	Observation	Inference
1	A small amount of sample RV was dissolved in distilled water.	A white precipitate formed but partially dissolved on heating.	Indicates presence of slightly soluble chloride salt, likely $PbCl_2$.
2	The solution obtained from step (1) was tested with dilute hydrochloric acid.	A white precipitate appeared and remained insoluble in excess HCl.	Confirms presence of Pb^{2+} ion, as $PbCl_2$ is sparingly soluble in cold water but more soluble in hot water.
3	The hot solution was allowed to cool slowly.	White needle-shaped crystals	Confirms presence of

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		reappeared on cooling.	$PbCl_2$ (lead chloride).
4	The filtrate was tested with potassium iodide solution.	A bright yellow precipitate formed.	Confirms presence of lead(II) ions as PbI_2 (lead iodide).
5	The sample solution was tested with dilute sulphuric acid.	A white precipitate formed which did not dissolve in excess acid.	Indicates presence of lead(II) ion (formation of $PbSO_4$).
6	A small amount of the sample solution was treated with silver nitrate solution.	A white curdy precipitate formed, soluble in dilute ammonia.	Confirms presence of chloride ion (Cl^-).
7	The sample solution was subjected to flame test.	No characteristic color observed.	Confirms presence of heavy metal cation (Pb^{2+}) which generally does not

			impart color to flame.

(a) Cation and Anion present in the sample:

The cation present is **Lead(II) ion (Pb^{2+})**.

The anion present is **Chloride ion (Cl^-)**.

(b) Molecular Formula of the Sample:

The molecular formula of the sample is **$PbCl_2$ (Lead(II) Chloride)**.

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