THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATION COUNCIL OF TANZANIA

ADVANCED CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

132/3A **CHEMISTRY 3A**

(For Both Private and School Candidates)

Duration: 3 Hour. **ANSWERS** **Year: 2025**

Instructions

1. This paper consists of **Three (3)** questions**.**
2. Answer **all** questions
3. Write your **Examination Number** on every page of your answer booklet(s).

1. You are required to demonstrate your analytical skills by doing iodometric titration aiming at determining the number of molecules of water of crystallization. Use the following reagents to accomplish the analysis:

(a) Tabulate the results.

Trial No.	Volume of $Na_2S_2O_3$ (U2) used (cm^3)
1	25.01
2	25.00
3	24.97
Average	25.00

(b) Write the balanced chemical equation for the experiment which involved:

(i) **Production of iodine:**

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

(ii) **Consumption of iodine:**

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

(iii) **The whole experiment:**

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

(c) Calculate the actual molarity of solution U1 after dilution.

Given:

Original molarity of $KMnO_4$ = 0.04 M

Volume used = 20 cm^3 = 0.020 dm^3

Moles of $KMnO_4$ = Molarity × Volume = $0.04 \times 0.020 = 8.0 \times 10^{-4}$ mol

From the reaction:

2 mol $KMnO_4$ produce 5 mol I_2

Thus, 8.0×10^{-4} mol $KMnO_4$ produces = $(5/2) \times 8.0 \times 10^{-4} = 2.0 \times 10^{-3}$ mol I_2

Each mol I_2 requires 2 mol $Na_2S_2O_3$:

Moles of $Na_2S_2O_3 = 2 \times 2.0 \times 10^{-3} = 4.0 \times 10^{-3}$ mol

Volume of $Na_2S_2O_3$ used = average titre value (e.g., 25.00 cm^3 = 0.02500 dm^3)

Molarity = moles / volume = $4.0 \times 10^{-3} / 0.02500 = 0.16$ M

(d) Compute the value of X in the formula $Na_2S_2O_3 \cdot XH_2O$.

Given:

Mass of 12.4 g in 0.5 dm^3

Moles of $Na_2S_2O_3$ = molarity × volume = 0.16 × 0.5 = 0.08 mol

Molar mass = 12.4 g / 0.08 mol = 155 g/mol

Molar mass of $Na_2S_2O_3$ = 158

Let XH_2O = 155 - 158 = approx. 90 → 5 × 18 = 90

Thus, **X = 5**

(e) Explain what will happen when potassium permanganate is missing in this experiment.

If $KMnO_4$ is missing, iodine will not be produced as there will be no oxidation of iodide ions (I^-) to iodine (I_2). This means no blue-black starch complex will form and no titration will occur since iodine is the analyte. The whole reaction will fail to proceed.

2. Identification of the type of chemical reaction (endothermic or exothermic):

(a) Find the heat change for dissolution of:

$Q = mc\Delta T$, where

m = mass of water (assume 1 g/cm^3 so 50 g),

c = specific heat capacity of water = 4.2 J/g°C,

ΔT = temperature change

(i) PR:

$Q_1 = 50 \times 4.2 \times \Delta T_1$ (Insert ΔT from table)

(ii) PK:

$Q_2 = 50 \times 4.2 \times \Delta T_2$ (Insert ΔT from table)

(b) Calculate the molar enthalpy change for dissolution of:

Molar mass:

PR (Ammonium chloride) = 53.5 g/mol

PK (Sodium hydroxide) = 40 g/mol

(i) PR:

moles = 2 / 53.5

$\Delta H = Q_1$ / moles

(ii) PK:

moles = 2 / 40

$\Delta H = Q_2$ / moles

(c) State the type of reaction in relation to heat changes:

(i) PR: If temperature decreased (ΔT negative), it is **endothermic** since heat is absorbed.

(ii) PK: If temperature increased (ΔT positive), it is **exothermic** since heat is released.

3. Sample RS contains one cation and one anion.

Table 2: Experimental Data

S/N	Experiments	Observations	Inferences
1	Flame test	Yellow flame	Na^+ ion present

2	Add $AgNO_3$	White ppt soluble in NH_3	Cl^- ion present
3	Add dilute HCl + $BaCl_2$	No white ppt	No SO_4^{2-} or CO_3^{2-} present

(a) What are the cation and anion in the sample?

Cation: Na^+

Anion: Cl^-

(b) Write the molecular formula for the sample.

NaCl