THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL

ADVANCED CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

132/3C **CHEMISTRY 3C**

(For Both School and Private Candidates)

Time: 3 Hours **ANSWERS** **Year: 2021**

Instructions

1. This paper consists of THREE questions.

2. Answer all questions.

1. You are provided with the following:

A: A solution made by dissolving 1.58 g of $KMnO_4$ in a 0.5 dm^3 of solution

B: A solution made by dissolving 5.8 g of $Na_2S_2O_3 \cdot XH_2O$ in 0.25 dm^3 of solution

C: A solution of 10% KI

D: A starch solution

E: A solution of dilute H_2SO_4

Summary:

Volume of pipette used = 25 cm^3

25 cm^3 of A liberated iodine that required 23.50 cm^3 of B for complete reaction

Questions

(a) State the role of solution D in this experiment.

Starch (solution D) is used as an indicator to detect the presence of iodine. It forms a blue-black complex with iodine and indicates the endpoint of titration by the disappearance of the colour.

(b) State the main purpose of adding solution C into a conical flask containing acidified solution of A.

KI (solution C) reacts with $KMnO_4$ to liberate iodine, which is then titrated against sodium thiosulphate.

(c) Why is it advisable to add solution D just close to the end point in this experiment?

Starch-iodine complex is stable; if added early, it can slow down the reaction and mask the endpoint. Adding it near the endpoint ensures a sharper and clearer colour change.

(d) Calculate:

(i) Concentration of A in g/dm^3

Given: 1.58 g in 0.5 dm^3

Concentration = $1.58 \div 0.5 = 3.16$ g/dm³

(ii) Molarity of A

Molar mass of $KMnO_4$ = 158 g/mol

Moles = $1.58 \div 158 = 0.01$ mol

Molarity = $0.01 \div 0.5 = 0.02$ mol/dm³

(iii) Molarity of $Na_2S_2O_3$

Volume of B = 23.50 cm³ = 0.0235 dm³

Molar ratio: 1 mol I_2 reacts with 2 mol $Na_2S_2O_3$

Assume all I_2 came from 25 cm³ of A with 0.02 M $KMnO_4$

$MnO_4^- + I^- \text{-----> } Mn^{2+} + I_2$

Moles of $KMnO_4 = 0.02 \times 25 \div 1000 = 0.0005$ mol

From redox stoichiometry, 1 mol MnO_4^- liberates 1 mol I_2

So moles of I_2 = 0.0005 mol

Moles of $Na_2S_2O_3 = 2 \times 0.0005 = 0.001$ mol

Molarity = $0.001 \div 0.0235 = 0.0426$ mol/dm³

(iv) Concentration of $Na_2S_2O_3$ in g/dm³

Molar mass = $158 + (X \times 18)$

molar mass ≈ 248 g/mol

Concentration = $0.0426 \times 248 = 10.5648$ g/dm³

(e) Find the value of X in $Na_2S_2O_3 \cdot XH_2O$

Mass of salt = 5.8 g

molar mass = $158 + 5 \times 18 = 248$

Moles = 5.8 ÷ 248 = 0.0234 mol

In 0.25 dm^3, M = 0.0936 mol/dm^3,

So X = 5

2. You are provided with the following:

C1: A solution of 0.1 M $Na_2S_2O_3$

C2: A solution of 0.1 M HCl

Table 1: Experimental Data (assume reasonable times):

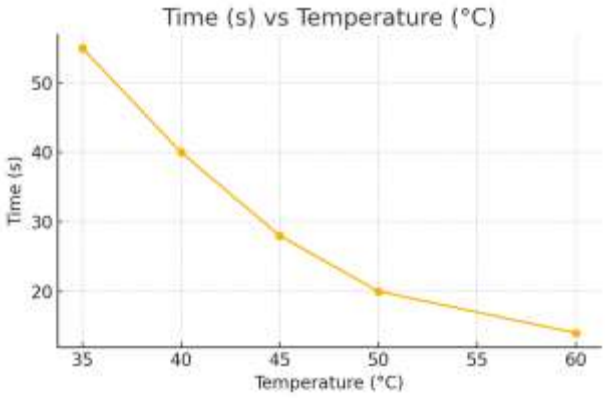
Temperature (°C)	Time (sec)	1/t (sec^{-1})
35	55	0.0182
40	40	0.0250
45	28	0.0357
50	20	0.0500
60	14	0.0714

Questions

(a) Write a balanced reaction equation for the experiment.

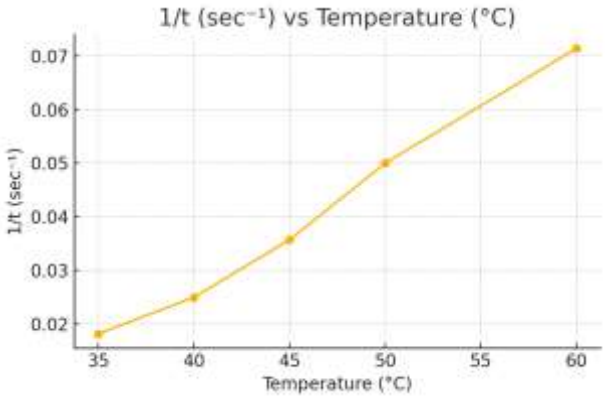
$S_2O_3^{2-} + 2H^+$ -----> $S(s) + SO_2(g) + H_2O$

(b)(i) Plot a graph of time (t) against temperature (°C)



Graph shows decreasing curve as temperature increases

(b)(ii) Plot a graph of 1/t against temperature (°C)



Graph shows direct linear relation—1/t increases with temperature

(c) Study the graphs in (b) and explain how the rate of reaction changes with temperature.

As temperature increases, time for reaction decreases, meaning the rate increases. This is shown by the increase in 1/t. The kinetic energy of particles increases with temperature, causing more frequent and effective collisions.

3. Sample K is a simple salt containing one cation and one anion. Carefully carry out qualitative analysis experiments to identify the ions present.

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

Test	Observation	Inference
(a) Appearance of the sample	White crystalline solid	Possible chloride or sulfate salt
(b) Action of heat on the sample	No change or faint acidic gas	Possible presence of ammonium salt
(c) Solubility	Soluble in water	Ionic nature of salt
(d) Action of aqueous sodium hydroxide on solution of K	White gelatinous precipitate formed	Al^{3+} possibly present
(e) Action of ammonia solution on solution of K	White precipitate dissolves in excess	Confirms Al^{3+}
(f) Action of $FeCl_3$ on K followed by dilute HCl and boiling	Blood red coloration disappears on boiling	Confirms presence of CH_3COO^- (acetate)
(g) Flame test for sample K	No distinct colour observed	Confirms absence of alkali/alkaline metals
(h) Confirmatory test	Al^{3+} and CH_3COO^- confirmed	Sample contains aluminium acetate

(ii) Write the molecular formula for the sample.

Molecular formula: $Al(CH_3COO)_3$

(iii) Write a balanced chemical equation of the reaction in experiment (b).

$(CH_3COO)^- + Fe^{3+}$ -----> $[Fe(CH_3COO)]^{2+}$ (red complex)

On boiling:

$[Fe(CH_3COO)]^{2+} + HCl$ -----> $FeCl_3 + CH_3COOH$ (blood red disappears)