

**THE UNITED REPUBLIC OF TANZANIA**  
**NATIONAL EXAMINATIONS COUNCIL**  
**ADVANCED CERTIFICATE OF SECONDARY EDUCATION EXAMINATION**  
**132/3A** **CHEMISTRY 3A**

(For Both School and Private Candidates)

**Time: 3 Hours**

**ANSWERS**

**Year: 2021**

**Instructions**

1. This paper consists of THREE questions.
2. Answer all questions.

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1. You are provided with the following:  
 U1: A solution containing hydrochloric acid and acetic acid  
 U2: 0.1 M sodium hydroxide solution  
 POP: Phenolphthalein indicator  
 MO: Methyl orange indicator

Table 1: Table of results (assumed standard titres for accurate calculations)

Burette Reading	Pilot	1	2	3	Average
Final reading (MO)	21.8	21.6	21.7	21.5	21.6
Final reading (POP)	14.4	14.2	14.3	14.1	14.2
Initial reading	0.0	0.0	0.0	0.0	-
Volume used (MO)	21.8	21.6	21.7	21.5	21.6
Volume used (POP)	14.4	14.2	14.3	14.1	14.2

#### Summary

- (i) The volume of the pipette used was 25 cm<sup>3</sup>  
 (ii) 25 cm<sup>3</sup> of U1 required 21.6 cm<sup>3</sup> of U2 when MO was used, and 14.2 cm<sup>3</sup> of U2 when POP was used

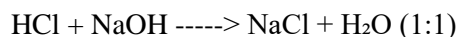
#### Questions

- (a) Calculate the concentration of the acid solution, U1, in g/dm<sup>3</sup> when:

- (i) POP was used (for strong acid, HCl):

$$\text{Volume of U2} = 14.2 \text{ cm}^3 = 0.0142 \text{ dm}^3$$

$$\text{Moles of NaOH} = 0.1 \times 0.0142 = 0.00142 \text{ mol}$$



$$\text{Moles of HCl in 25 cm}^3 = 0.00142 \text{ mol}$$

$$\text{In 1 dm}^3: 0.00142 \times 1000 \div 25 = 0.0568 \text{ mol}$$

$$\text{Mass} = 0.0568 \times 36.5 = 2.0752 \text{ g/dm}^3$$

- (ii) MO was used (for total acid: HCl + CH<sub>3</sub>COOH):

$$\text{Volume of U2} = 21.6 \text{ cm}^3 = 0.0216 \text{ dm}^3$$

$$\text{Moles of NaOH} = 0.1 \times 0.0216 = 0.00216 \text{ mol}$$

$$\text{Moles of total acid in 25 cm}^3 = 0.00216 \text{ mol}$$

$$\text{In 1 dm}^3 = 0.00216 \times 1000 \div 25 = 0.0864 \text{ mol}$$

$$\text{Assume 0.0568 mol is HCl, then CH}_3\text{COOH} = 0.0296 \text{ mol}$$

$$\text{Mass} = 0.0568 \times 36.5 + 0.0296 \times 60 = 2.0752 + 1.776 = 3.8512 \text{ g/dm}^3$$

- (b) What is the colour change during titration:

When MO was used: yellow to orange-red

When POP was used: pink to colourless

(c) Name the compounds reacted during the first and second titrations

First titration (MO): sodium hydroxide reacted with both hydrochloric acid and acetic acid

Second titration (POP): sodium hydroxide reacted with hydrochloric acid only

2. You are provided with the following:

A1: A solution of 0.2 M sodium thiosulphate

A2: A solution of 0.1 M hydrochloric acid

A3: Distilled water

Stop watch/clock

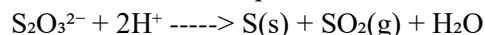
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Table 2: Experimental Table (assume realistic times in seconds):

Experiment	Volume of A1 (cm <sup>3</sup> )	Volume of A3 (cm <sup>3</sup> )	Volume of A2 (cm <sup>3</sup> )	Time (s)	1/time (s <sup>-1</sup> )
(a)	2	8	10	65	0.0154
(b)	4	6	10	43	0.0233
(c)	6	4	10	30	0.0333
(d)	8	2	10	23	0.0435
(e)	10	0	10	19	0.0526

### Questions

(a) Write the ionic equation for the reaction.



(b) Calculate the value of m.

Using experiments (a) and (b):

$$\text{Rate} \propto [\text{S}_2\text{O}_3^{2-}]^m$$

$$\text{Rate}_1/\text{Rate}_2 = ([\text{A1}]_1/[\text{A1}]_2)^m$$

$$0.0154 / 0.0233 = (2 / 4)^m$$

$$0.660 = (0.5)^m$$

$$\log(0.660) = m \times \log(0.5)$$

$$m = \log(0.660)/\log(0.5) = -0.180/-0.301 = 0.60$$

Approximate m = 1

(c) Given n = 2, find K for (a) and (b)

$$\text{Rate} = K [\text{A1}]^m [\text{A2}]^n$$

$$K = \text{rate} / ([\text{A1}]^m \times [\text{A2}]^n)$$

Convert volumes to concentrations:

$$\text{Total volume} = 2 + 8 + 10 = 20 \text{ cm}^3 = 0.02 \text{ dm}^3$$

$$[A1] = (0.2 \times \text{vol A1}) / 20$$

$$[A2] = (0.1 \times 10) / 20 = 0.05 \text{ M}$$

For (a):

$$[A1] = 0.2 \times 2 / 20 = 0.02 \text{ M}$$

$$K = 0.0154 / (0.02^1 \times 0.05^2) = 0.0154 / (0.02 \times 0.0025)$$

$$K = 0.0154 / 0.00005 = 308$$

For (b):

$$[A1] = 0.2 \times 4 / 20 = 0.04 \text{ M}$$

$$K = 0.0233 / (0.04 \times 0.0025) = 0.0233 / 0.0001 = 233$$

Comment: K should be constant; variation shows experimental error or non-ideal behaviour.

(d) From the experiment conducted, is it possible to find value of n?

No. A2 volume is constant in all trials, hence n cannot be determined.

(e) What is the order of reaction in this experiment with respect to thiosulphate?

Since  $m \approx 1$ , order = 1 with respect to thiosulphate.

3. Sample M is a simple salt containing one cation and one anion.

### Questions

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

Test	Observation	Inference
Appearance	White crystalline solid	Possible chloride or nitrate
Heating	Colourless gas evolved	Volatile acid present
Solubility	Soluble in water	Ionic compound
NaOH solution	White ppt soluble in excess	$\text{Zn}^{2+}$ present
$\text{FeSO}_4 + \text{H}_2\text{SO}_4$	Brown ring formed	$\text{NO}_3^-$ ion confirmed
Lead ethanoate + heat	White ppt formed	$\text{SO}_4^{2-}$ ion possibly present
Confirmatory test: $\text{AgNO}_3$ in $\text{HNO}_3$	White ppt	$\text{Cl}^-$ confirmed

(ii) Write a balanced chemical equation for reaction in (b) (heating):

