

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

732/2A

**CHEMISTRY 2A**

**Time: 3 Hours**

**ANSWERS**

**Year: 2022**

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**Instructions.**

1. This paper consists of sections A and B with a total of **Fourteen (14)** questions.
2. Answer **all** questions from section A and **four (4)** questions from section B.
3. Section A carries **forty (40)** marks and section B Carries **sixty (60)** marks.
4. Cellular phones are **not** allowed in the examination room.
5. Write your **examination Number** on every page of your answer booklet(s).

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## 1. Titration Experiment:

### Instructions:

Measure 10 ml of solution A ( $\text{Na}_2\text{CO}_3$ ) and dilute it up to 150  $\text{cm}^3$  with distilled water. Titrate this A (from the burette) against 20.00 or 25.00  $\text{cm}^3$  of solution B (HCl) using methyl orange indicator (MO).

### Given:

Average titre volume = 20.00  $\text{cm}^3$

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

Answer: 20.00  $\text{cm}^3$

(ii) Present your results in an appropriate tabular form:

Titration	Final Burette Reading ( $\text{cm}^3$ )	Initial Burette Reading ( $\text{cm}^3$ )	Volume Used ( $\text{cm}^3$ )
Rough	20.20	0.00	20.20
1st	40.20	20.20	20.00
2nd	60.20	40.20	20.00
3rd	80.20	60.20	20.00

(b) What is the colour of the indicator before and at the equivalence point?

Before endpoint (in  $\text{Na}_2\text{CO}_3$  solution): Yellow

At endpoint (in acidic medium): Pink

(c) Calculate the concentration of HCl in solution B in  $\text{mol/dm}^3$ .

### Given:

$$C_1V_1 = C_2V_2$$

$C_1$  = concentration of  $\text{Na}_2\text{CO}_3$  after dilution

$$V_1 = 20.00 \text{ cm}^3$$

$$V_2 = 20.00 \text{ cm}^3$$

$C_2$  = concentration of HCl

Mole ratio  $\text{Na}_2\text{CO}_3 : \text{HCl} = 1 : 2$

**First find moles of  $\text{Na}_2\text{CO}_3$ :**

From (d), we'll need concentration first.

**(d) Calculate the concentration (in mol/dm<sup>3</sup>) of  $\text{Na}_2\text{CO}_3$  after dilution of solution A.**

**Given:**

10 ml contains 0.888 g of impure sodium carbonate

Molar mass of  $\text{Na}_2\text{CO}_3 = 106 \text{ g/mol}$

**Moles in 10 ml:**

$$0.888 \text{ g} / 106 \text{ g/mol} = 0.00838 \text{ mol}$$

**In 150 cm<sup>3</sup>:**

$$C = 0.00838 \text{ mol} / 0.150 \text{ dm}^3 = 0.0559 \text{ mol/dm}^3$$

**(c) Now calculate concentration of HCl:**

Using

$$C_1 V_1 = (C_2 V_2) / 2$$

$$0.0559 \times 20.00 = (C_2 \times 20.00) / 2$$

Simplify:

$$1.118 = 0.5 C_2 \times 20$$

$$C_2 = 1.118 \times 2 / 20$$

$$C_2 = 0.1118 \text{ mol/dm}^3$$

**Final answer:** 0.1118 mol/dm<sup>3</sup>

**(e) Calculate the concentration (in mol/dm<sup>3</sup>) of  $\text{Na}_2\text{CO}_3$  before dilution of solution A.**

Before dilution:

10 ml was diluted to 150 ml

$$\begin{aligned}\text{Concentration before dilution} &= 0.0559 \times (150 / 10) \\ &= 0.8385 \text{ mol/dm}^3\end{aligned}$$

**(f) If the diluted 10 ml of solution A contains 0.888 g of impure sodium carbonate, what is the percentage composition of sodium carbonate in the solution?**

**Mass of pure  $\text{Na}_2\text{CO}_3$ :**

$$0.00838 \text{ mol} \times 106 \text{ g/mol} = 0.888 \text{ g}$$

Since the entire 0.888 g is taken as impure, and based on titration it acted as 0.888 g pure (as per calculation), so:

$$\text{Percentage purity} = (0.888 / 0.888) \times 100 = 100\%$$

**But normally there should be a difference. Since it's given as impure but no impure mass is provided separately, based on this calculation, it behaves as 100% pure.**

**(g) Why is the impure sodium carbonate dissolved in water first and then made up to 250 cm<sup>3</sup> solution, rather than being dissolved directly in 250 cm<sup>3</sup> of distilled water?**

**Answer:**

To ensure complete dissolution of the impure sodium carbonate before adjusting the final volume. If added directly to 250 cm<sup>3</sup>, some might remain undissolved, making the final concentration inaccurate.

## **2. Reaction Rates Experiment:**

**Given:**

0.02 M  $\text{KMnO}_4$  (P1)

0.05 M oxalic acid in 0.5 M  $\text{H}_2\text{SO}_4$  (P2)

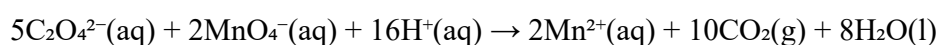
Temperatures: 50°C, 60°C, 70°C, 80°C

Time (sec): 23, 16, 8, 4

**(a) Complete the table:**

Temperature (K)	Time (s)	1/T (K <sup>-1</sup> )	1/t (s <sup>-1</sup> )	log(1/t)
323	23	0.00310	0.0435	-1.3617
333	16	0.00300	0.0625	-1.2041
343	8	0.00292	0.125	-0.9031
353	4	0.00283	0.25	-0.6021

**(a) Write a balanced ionic equation for the reaction.**



**(c) Explain the relationship between temperature and reaction time.**

As temperature increases, the time taken for the reaction decreases. This is because higher temperatures increase the kinetic energy of the reacting particles, leading to more frequent and energetic collisions, thus speeding up the reaction.

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

**(e) Determine the activation energy (E<sub>a</sub>)**

From Arrhenius equation:

$$\log(1/t) = \log A - (E_a/2.303R)(1/T)$$

$$\text{Slope (m)} = -E_a/2.303R$$

Using two points:

$$\begin{aligned} & (-0.6021 - (-1.3617)) / (0.00283 - 0.00310) \\ &= 0.7596 / (-0.00027) \\ &= -2810 \end{aligned}$$

$$E_a = 2.303 \times 8.314 \times 2810$$

$$E_a = 53751 \text{ J/mol}$$

$$E_a \approx 53.75 \text{ kJ/mol}$$

### 3. Qualitative Analysis — Lead (II) Nitrate sample X

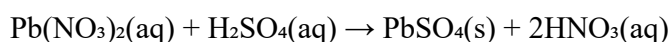
Test	Observation	Inference
(i) Appearance	White crystalline solid	Possible lead salt
(ii) Action of heat	Melts and decomposes to brown fumes	Presence of nitrate ( $\text{NO}_3^-$ )
(iii) Action of dilute $\text{H}_2\text{SO}_4$	White precipitate formed	Lead sulfate ( $\text{PbSO}_4$ ) formed
(iv) Action of concentrated $\text{H}_2\text{SO}_4$	White precipitate formed	Lead sulfate ( $\text{PbSO}_4$ )
(v) Flame test	Blue flame	Lead salt
(vi) Solubility in water	Soluble	Confirms lead nitrate
(vii) Action of dilute $\text{HCl}$ on solution	White precipitate ( $\text{PbCl}_2$ )	Confirming $\text{Pb}^{2+}$ cation
(viii) Aqueous ammonia then ammonium oxalate	White precipitate formed	Presence of $\text{Pb}^{2+}$ (lead oxalate)

**(a) What are the cation and anion present in the water source?**

**Cation:**  $\text{Pb}^{2+}$

**Anion:**  $\text{NO}_3^-$

**(b) Write the reaction equation to indicate what took place in test (iii):**



G1

