CHRISTIAN SOCIAL SERVICES COMMISSION (CSSC)

NORTHEN ZONE JOINT EXAMINATIONS SYNDICATE (NZJES)

FORM FOUR PRE-NATIONAL EXAMINATIONS AUGUST 2024

CHEMISTRY 2B

ACTUAL PRACTICAL B

MARKING SCHEME

Question 1

a) Solutions P was acid
Solution Q was base } @ **0.5** = **01** Mark

Reason:

Solution P turns **Blue** litmus paper to **Red** and red litmus paper remains red

(**0.5 Marks**)

Solution Q turns **Red** litmus paper **Blue** and Blue litmus paper remains blue

(**0.5 Marks**)

b) Best **indicator** for the neutralization reaction between Solutions **P (CH_3COOH)** and **Q** (KOH) was **POP** (**Phenolphthalein**). (**0.5 Marks**)

Reason: Solutions P (CH_3COOH) is **a weak acid**
Solution Q (KOH) is a **strong Base** (**0.5 Marks**)

c) (i) Table 1 (Experimental results for Qn 1)

TITRATION/Burette Readings	**PILOT**	**1**	**2**	**3**
Final reading (cm^3)	11.90	21.90	31.90	41.90
Initial reading (cm^3)	1.00	11.90	21.90	31.90
Volume of Acid used (Va) (cm^3)	10.90	10.00	10.00	10.00

Correct data entry in the above table **05 Marks**

(ii) The volume of pipette used was **20.00** cm^3 (**0.5 Marks**)

(iii) Average volume of the acid solution used

$$V_a = \frac{(10.00 + 10.00 + 10.00)}{3}\ cm^3$$

$$= \frac{30.00}{3}\ cm^3 = \mathbf{10.00}\ cm^3 \qquad (\mathbf{01\ Mark})$$

(iv) The colour change at the end point was from **Pink** to **Colourless** (**01 Mark**)

(v) ***Summary***;

10.00 cm^3 of solution **P** required **20.00** cm^3 of solution **Q** for complete neutralization reaction.

(**01 Mark**)

d) Balanced chemical equation for the reaction between acid and base used in this experiment.

$CH_3COOH\ (aq) + KOH\ (aq) \longrightarrow CH_3COOK\ (s) + H_2O\ (l)$ (**01.5 Mark**)

e) (i) Concentration of Ethanoic (CH_3COOH) acid in;

(a) Moles/dm^3

From Data given above

Ethanoic acid (CH_3COOH) was prepared as follows;

Volume of conc. acid (Vc) = $200cm^3$ = **0.2** dm^3

Where

$1\ dm^3 = 1000\ cm^3$

$x = 200cm^3$

by cross multiplying we get **x = 0.2** dm^3 **Vc = 0.2** dm^3

Molarity of conc. acid (Mc) = 2 M

Volume of dilution (Vd) = 2 dm^3

From: Dilution Law**:** **MdVd = McVc**

$$\mathbf{Md} = \frac{\mathbf{McVc}}{\mathbf{Vd}}$$

$$= \frac{2M \times 0.2\ dm^3}{2\ dm^3}$$

Where; **Mc** = Molarity of conc. acid

Md = Molarity of diluted acid

Vc = Volume of Conc. acid

Vd= Volume of Diluted acid

Concentration of Ethanoic acid (CH_3COOH) in moles/ dm^3 = **0.2** Moles/dm^3 (**01.5 Mark**)

(ii) Concentration of Ethanoic acid (CH_3COOH) g/dm^3

Molar mass of CH_3COOH = 12 + (1x3) + 16 + 16 + 1 = 48 g/mol

From:

$$\text{Molarity} = \frac{\text{Concentration g/dm}^3}{\text{Molar mass (g/mol)}}$$

Then

Concentration g/dm^3 = Molarity x Molar mass (g/mol)

Concentration of Ethanoic acid (CH_3COOH) = 0.2 x 48 = 9.6 g/dm^3 (**01.5 Mark**)

f) Calculate;

(i) Concentration of Base Solution (KOH) in **moles/dm^3**

From balanced chemical equation above

Na = 1, Nb = 1

From the Table of titration above;

Volume of acid used (Va) = 10.00 cm^3 Pipette used (Vb) = 20.00 cm^3

Also from given information at the beginning of the Qn 1; Md = Ma = 0.2 M

Where; **Ma** = Molarity of Acid

Thus from the Formula: **MbVbna = MaVanb** **Mb** = Molarity of Base

Va = Volume of Acid

Vb = Volume of Base

Na and **Nb** are No. of acid and Base respectively.

$$\mathbf{Mb} = \frac{\mathbf{MaVanb}}{\mathbf{Vbna}}$$

$$Mb = \frac{0.2M \times 10.00\ cm^3 \times 1}{20.00\ cm^3 \times 1}$$

$$Mb = 0.10\ M = 0.10\ Moles/dm^3$$

Therefore; Concentration of Base Solution (KOH) in **moles/dm^3** = 0.10 $Moles/dm^3$ (**01.5 Mark**)

Concentration of Base Solution (KOH) in **g/dm^3** respectively.

From formula;

$$\text{Molarity} = \frac{\text{Concentration g/dm}^3}{\text{Molar mass (g/mol)}}$$

But Molar of KOH = 56g/mol

Concentration g/dm^3 = Molarity x Molar mass (g/mol)

Concentration g/dm^3 = 0.1 x 56

Concentration of pure KOH = 5.6g/dm^3 (**01.5 Mark**)

(ii) Percentage **(%)** purity of the base Solution (KOH)

From the given information in this question, it was seen that;

1.45g of impure Potassium hydroxide was prepared in 250mls of the solution.

From this information we get Concentration of impure KOH as follows;

1.45g = 250 mls

xg = 1000mls

Cross multiplying we get

$$x = \frac{1.45g \times 1000mls}{250mls}$$

$$= 5.8g/ml = 5.8\ g/dm^3$$

Thus; **Concentration of impure KOH** = $5.8\ g/dm^3$

We get Percentage **(%)** purity of the base Solution (KOH) as follows;

$$\frac{\text{Concentration of pure KOH solution } g/dm^3}{\text{Concentration of impure KOH solution } g/dm^3} \times 100\% = \frac{5.6\ g/dm^3}{5.8\ g/dm^3} \times 100\% = \mathbf{96.55}\%$$

Percentage (%) purity of pure base Solution (KOH) = 96.55% (01.5 Mark)

g) **two (2) possible sources of errors**

(any two (2) errors with two (2) overcome @ 01 = **04 Marks**)

	Source of error	How to overcome/minimize
(i)	Water or any other impurities on vessels like conical flask, burette, pipette	To make sure that all vessels used are rinsed with their respective solution.
(ii)	Delay in stopping acid from the burette when end point has been reached	To make sure that end point of reaction is reached when acid from burette is at drop by drop speed and stop immediately after colour change is noticed.
(iii)	Forcing last drop of base from pipette during titration	Do not force the last drop of base in the pipette as it is outside the calibration of the pipette.

h) The functional group of Ethanoic acid (CH_3COOH) is carboxyl ***-CHOOH*** (**0.5 Marks**)

IUPAC name of Ethanoic acid (CH_3COOH) is ***Acetic acid***. (**0.5 Marks**)

Question No. 2

Table 1

Experiment No	Volume of N (HCl) (cm^3)	Volume of M ($Na_2S_2O_3$) (cm^3)	Volume of distilled water (cm^3)	Concentration of M ($Na_2S_2O_3$) ($moles/dm^3$)	Time (s)	Rate (s^{-1})
(i)	10	10	0			
(ii)	10	8	2			
(iii)	10	6	4			
(iv)	10	4	6			

Questions

a) Complete (fill) blank columns in Table 1 above **(06 Marks)**

b) The aim of this experiment was to *demonstrate the effect of concentration on the rate of chemical reaction for the reaction between $Na_2S_2O_3$ solution and HCl acid* (**01.5 Mark)**

c) (i) To write a net ionic equation for the reaction between solution U and V

Ionic equation is usually written in five steps as follows;

@ step 01 = 05 Marks

Step 1: writing chemical equations in words

Hydrochloric acid reacts with sodium thiosulphate to form sodium chloride, sulphur, sulphur dioxide and water.

Step 2: Equation in chemical symbols and balancing it.

$$2HCl\ (aq) + Na_2S_2O_3\ (aq) \longrightarrow 2NaCl(aq) + S_{(s)} + SO_{2(g)} + H_2O_{(l)}$$

Step 3: Splitting all soluble ionic compounds into individual ions

$$2H^+(aq) + 2Cl^-\ (aq) + 2Na^+(aq) + 2S_2O_3^-\ (aq) \longrightarrow 2Na^+(aq) + 2Cl^-(aq) + S_{(s)} + SO_{2(g)} + H_2O_{(l)}$$

Step 4: Cancel out spectator ions

$$2H^+(aq) + \cancel{2Cl^-}\ (aq) + \cancel{2Na^+}(aq) + 2S_2O_3^-\ (aq) \longrightarrow \cancel{2Na^+}(aq) + \cancel{2Cl^-}(aq) + S_{(s)} + SO_{2(g)} + H_2O_{(l)}$$

Step 5: Writing the net ionic equation

$$2H^+(aq) + 2S_2O_3^-\ (aq) \longrightarrow S_{(s)} + SO_{2(g)} + H_2O_{(l)}$$

(ii) the name of product which causes the solution to cloud letter X is **Sulphur**

(01 Mark)

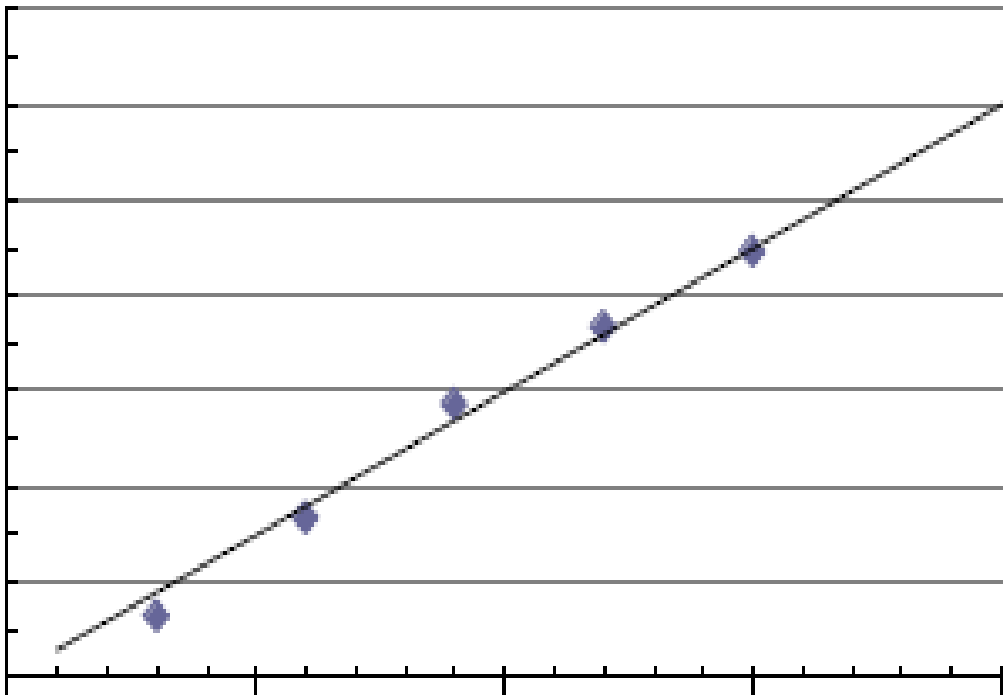
d) (i) Plot the graph of Volume of $Na_2S_2O_3$ solution against Rate (s^{-1})

The nature of graph

Volume (cm^3) of $Na_2S_2O_3$ solution against Rate (s^{-1}) (**02 Marks**)

Things to Note:

- Title of the graph (with its respective units) (**01 MARK**)
- Correct labeled axes (with units) (**01 MARKS**)
- Scale: (Horizontal and Vertical scale) – with respective units (**02 MARKS**)



(ii) Conclusion to be drawn from the graph above

Decrease in concentration of Sodium thiosulphate solution decreases the rate of chemical reaction and vice versa. (**01.5 Mark)**

e) Two (2) possible sources of errors that might hinder this experiment and in each case, state how to overcome the error.

Any two errors: @ error = 01 x 2 = **02 Marks**

@ control measure 01 x 2 = **02 Marks**

Source of error	**How to overcome/ correct**
(i) Water droplets or remains (impurities) on vessels like beaker, measuring cylinder.	- Make sure all impurities from vessels are removed/emptied completely.
(ii) Delay in starting and or stopping stop watch during experiment.	- Make sure stop watch is started and stopped carefully (on time) as reaction starts or ends.
(iii) Use of dirty or broken apparatus like measuring cylinder.	- Never use dirty or broken apparatus