CHEMISTRY PRACTICAL SOLUTIONS - IV

COMMON PRACTICALS

1. VOLUMETRIC ANALYSIS
2. RATE OF CHEMICAL REACTION AND EQUILIBRIUM
3. QUALITATIVE ANALYSIS

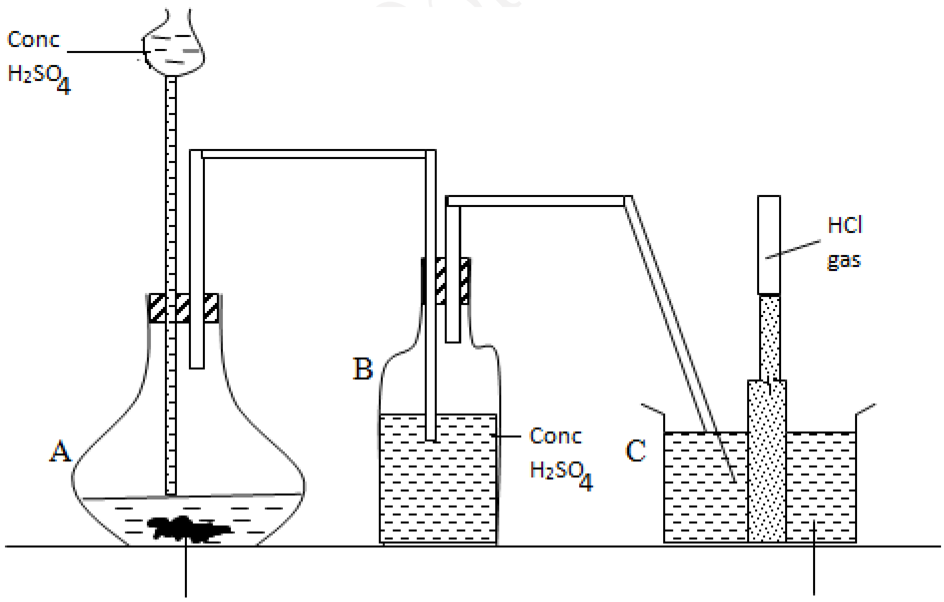


Fig. 1

SUBJECT HANDOUT

Prepared by Sir. Donny Company

A) Volumetric analysis

Practical 01

You are provide with the following
Solution G containing 0.05 M sulphuric acids
Solution H containing 2 g of XOH in 500cm^3 of the solution
Solution F, methyl orange indicator
Determine the atomic mass of X in XOH

Procedure:
Put solution G in the burette. Pipette 20cm^3 or (25cm^3) of solution H into the conical flask. Add two or three drops of methyl orange indicator. Titrate solution H against solution G from the burette until a colour change is observed. Note the burette reading. Repeat the procedure to obtain three more readings,

a) Record your results in a table as shown below,
i) Burette readings

Titration	Pilot	1	2	3
Final reading(cm^3)				
Initial reading (cm^3)				
Volume used (cm^3)				

ii) The volume of pipette was…………cm^3
iii) Calculate the mean titre volume
iv) The volume of solution H needed for complete neutralization of……...cm^3 of solution G was……..cm^3
b) Write a balanced chemical equation for the reaction between solution G and H.
c) Calculate the
i) Molarity of H
ii) Concentration of H in g/dm^3
iii) Molar mass of XOH
iv) Atomic mass of X in compound XOH

Solution

(a) (i) burette reading (data from the laboratory)

Titration	Pilot	1	2	3
Final reading(cm^3)	25.20	25.10	24.90	25.00
Initial reading (cm^3)	0.00	0.00	0.00	0.00
Volume used (cm^3)	25.20	25.10	24.90	25.00

(ii) The volume of pipette used was 25cm^3

(iii)The mean titre volume $= \frac{25.10+24.90+25.00}{3}$

$= \frac{75.00}{3}$

$= 25.00\text{cm}^3$

(iv) The volume of solution H needed for complete neutralization of 25cm^3 of solution G was 25.00cm^3

(b) Balanced chemical equation for the reaction between solution G and H

$$H_2SO_{4(aq)} + 2XOH_{(aq)} \rightarrow X_2SO_{4(aq)} + 2H_2O_{(l)}$$

(c) i) Molarity of H

From $\frac{mava}{mbnb} = \frac{na}{nb}$

Given that

Ma= molarity of acid

Na = number of moles of acid

Nb= number of moles of base

Va= volume of acid

Vb= volume of base

Mb= molarity of base

$$\frac{0.05}{mb} x \frac{25.00}{25.00} = \frac{1}{2}$$

$$Mb = \frac{0.05x25x2}{25}$$

$\therefore$ Molarity of H = 0.1M

ii) Concentration of H in g/dm^3

$$= \frac{2x1000cm^3}{500cm^3}$$

$= 4\ g/dm^3$

iii) Molar mass of XOH

$$\frac{concetration\ (g/dm^3)}{molarity}$$

$$\frac{4\ g/dm^3}{0.1}$$

$= 40g/mol.$

iv) Atomic mass of X in Compound XOH

Molar mass of XOH = 40

X+16+1 =40

X+17=40

X= 40-17

X=23g.

$\therefore$ Atomic mass of X = 23g.

Practical 02

Your are provided with the following:-

i) Solution Y: containing 3.575g of pure hydrated sodium. Carbonate ($Na_2C0_3.ZH20$) per $0.25dm^3$ of the solution.

ii) Solution X: Obtained diluting $250cm^3$ of 0.4M hydrochloric acid to $1000cm^3$ of the solution with distilled water.

iii) Methyl orange indicator labeled S.

Procedure:

Put solution X in the burette $20cm^3$ (or $25cm^3$) of solution Y into titration flask. Titrate solution X from burette against solution Y in the titration flask until the colour change is observed. Note the burette reading. Repeat the procedure to obtain three more readings and record your results in a table a shown below.

Experiment	**Pilot**	**1**	**2**	**3**
Final reading(cm^3)				
Initial reading (cm^3)				
Volume used (cm^3)				

i) The colour change at the end point was from ……………to…………

ii) ……cm^3 of solution X required…………cm^3 of solution Y for completed reaction

iii) Determine the concentration of solution Y in mols dm^{-3} and in gdm^{-3}

iv) Determine the molar mass of the hydrated sodium carbonate ($Na_2CO_3.ZH_2O$)

v) Calculate the value of Z and percentage water of crystallization in the formula $Na_2C0_3 .ZH_2O$

Solution

Table of results

Experiment	**Pilot**	**1**	**2**	**3**
Final reading(cm^3)	25.20	25.10	24.90	25.00
Initial reading (cm^3)	0.00	0.00	0.00	0.00
Volume used (cm^3)	25.20	25.10	24.90	25.00

- Volume of pipette used was $= 25cm^3$
- Average volume of solution x $= \frac{25.00+25.00+25.00}{3}$

$= \frac{75.00}{3}$

$= 25.00cm^3$

i) The colour change at the end point was from yellow to orange/pink

ii) $25.00cm^3$ of solution X required $25cm^3$ of solution Y for complete reaction.

iii) Concentration of solution Y mols dm^{-3} and ingdm^{-3} .

From $M_1V_1 = M_2V_2$

Where

M_1 = molarity of conc. acid

V_1 = volume of conc. acid

M_2 = molarity diluted acid.

V_2 = volume of diluted acid.

$M_2 = \frac{M_1V_1}{V_2}$

$= \frac{0.4 \times 250}{1000}$

- Molarity of HCl (X) = 0.1 $moldm^{-3}$
- Molarity of soln X (HCl) in g/dm^3

= molarity x mwt

$= 0.1\ moldm^{-3} \times 36.5gmol^{-1}$

$= 3.65\ g/dm^3$

$\therefore$ Concentration of solution Y in g/dm^3

Equation for the reaction

$Na_2CO_{3(aq)} + 2HCl_{(aq)} \rightarrow 2NaCl_{(aq)} + H_2O_{(l)} + CO_{2(g)}$

Mole ratio 1:2

From, $\frac{mbvb}{mava} = \frac{nb}{na}$

Where

Mb= molarity of base

Ma= molarity of acid

Va= volume of acid

Vb = volume of base

Na= number of moles of acid

Nb= number of moles of base.

$Mb = \frac{MaVaNb}{VbNa}$

$= \frac{0.1x25x1}{25x2}$

$= 0.05M$

Mass concentration of base

$= \frac{3.575gdm^{-3}}{0.25dm^3}$

$= 14.3gdm^{-3}$

iv. Molar mass of the hydrated sodium carbonate $(Na_2CO_3.ZH_2O)$

$= \frac{\text{mass concetration}}{\text{molarity}}$

$= \frac{14.3gdm^{-3}}{0.05moldm^{-3}}$

$= 286g/mol$

v. The value (No.) of molecules of water of crystallization

From, molar mass of $Na_2CO_3.ZH_2O = 286$

We have,

106 +18Z =286

18Z=286 – 106

18Z= 180

$Z = \frac{180}{18}$

$= 10$

Then it becomes $Na_2CO_3 . 10H_2O$

% of water of crystallization

$= \frac{10H_2O}{Na_2CO_3.10H_2O}$

$= \frac{180}{286} x100$

$= 62.93\%$

Also alternative method is acceptable.

Practical 03

Your are provided with the following

AA A solution of 0.2M nitric acid (HNO_3)

BB A solution of 4.2g NaxC03 per 0.5 dm^3 of solution

MO is methyl orange indicator

Procedure

Put solution AA into the burette. Pipette $20cm^3$ or $25cm^3$ of solution BB in a titration flask. Add two drops of methyl orange4 indicator into the titration flask.

Titrate solution BB against A A until the end point is reached. Record the burette reading. Repeat the procedure to obtain three more reading and record your results in a tabular form.

Questions

a)(i) Calculate the average titre volume

(ii) Summary cm^3 of solution BB required…..cm^3 of solution AA for complete reaction.

b) If the mole ratio for the reaction is 1:1 find

i) Concentration of $NaxCO_3$ in mol/dm^3 and g/ dm^3

ii) Molecular mass of $NaxCO_3$

iii) Atomic mass of x and replace it in the reaction in this experiment.

c) Write a balanced chemical equation for the reaction in this experiment.

d) What is the significance of the indicator in this experiment?

e) Why is there a colour change enough acid has been added to the base?

Solution

Table of results

Titration	**Pilot**	**1**	**2**	**3**
Final reading(cm^3)	10.20	20.30	30.30	40.20
Initial reading (cm^3)	0.00	10.20	20.30	30.30
Titre volume (cm^3)	10.20	10.10	10.00	9.90

The volume of pipette used was $20.00cm^3$

(i) Average titre volume = $\frac{10.10+10.00+9.90}{3} = \frac{30.00}{3}$

$= 10.00cm^3$

(ii) Summary $20cm^3$ of solution BB required $10.00cm^3$ of solution AA for complete reaction.

(b) If the mole ratio for the reaction was 1:1

Then, concentration of $NaxCO_3$ will be?

Given that

$V_a = 10cm^3$

$V_b = 20cm^3$

$M_a = 0.2M$

$M_b = ?$

(i) Concentration of $NaxCO_3$

From the relation

Where

n_a Is the number of moles of acid?

n_b Is the number of moles of bases?

M_a Is molarity of acid?

M_b Molarity of acid

V_a Volume of acid

V_b Volume of base

$\frac{n_a}{n_b} = \frac{m_a v_a}{m_b v_b}$

$\frac{1}{1} = \frac{0.2x10}{m_b x20}$

$m_b = \frac{0.2x10}{20}$

$\therefore$ Concentration $mol/dm^{-3} = 0.1mol/dm^{-3}$

Concentration in g/dm^3

$= 4.2g \equiv 0.5dm^3$

$X \equiv 1.0dm^3$

$= \frac{4.2x1}{0.5}$

$\therefore$ Conc in $g/dm^3 = 8.4g/dm^3$

(ii) Molar mass of $NaxCO_3$ = molarity x conc. g/dm^3

(Molecular mass) = $0.1mol/dm^{-3}$ x $8.4gdm^3$

$= 84g/mol$

(iii) Atomic mass of x in the formula $NaxCO_3$

Given, $NaxCO_3 = 84$

(iii) Atomic mass of x in the formula $NaxCO_3$

Given, $NaxCO_3 = 84$

$23 + x + 12 + (16x3) = 84$

$23 + x + 60 = 84$

$83 + x = 84$

X= 84 - 83

=1g/mol

∴ Atomic mass of 1g/mol

And this is probably hydrogen atom.

(c) Balanced chemical equation for the reaction

$$HNO_{3(aq)} + NaHCO_{3(aq)} \rightarrow NaNO_{3(aq)} + CO_{2(g)} + H_2O_{(l)}$$

(d) The indicator in this experiment signifies or it indicates the end point of the reaction between the acid solution AA and the base solution BB.

(It is acting as a referee between acid and base reaction)

(e) There is a colour change when acid has been added to the base due to the Ph change of the indicator used.

Practical 04

In an experiment, 0.1MHC1 was titrated against hydrated sodium carbonate ($Na_2CO_3\ XH_2O$) solution of concentration 14.3 g/dm^3. The volume of pipette used was 20cm^3 and the burette readings were recorded as shown in the table below.

Burette readings

Experiment	Pilot	1	2
Final reading (cm^3)	22,.00	40.90	21.95
Initial reading (cm^3)	01.00	21.00	02.00
Titer volume(cm^3)			

Table 1

a) Complete the table by filling in the values of titer volume of each column
b) Calculate the mean titer volume.
c) Write a balanced chemical equation for the reaction. Which took place during the titration of sodium carbonate solution and hydrochloric acid?
d) Calculate the
i) Molarity of sodium carbonate
ii) concentration in g/dm^3 of sodium carbonate.
iii) Number of water of crystallization, x in $Na_2CO_3\ XH_2O$

Solution

(a) Table 1 (table of results)

Experiment	**Pilot**	**1**	**2**
Final reading (cm^3)	22,.00	40.90	21.95
Initial reading (cm^3)	01.00	21.00	02.00
Titer volume(cm^3)	21.00	19.00	19.95

(b) The mean titer volume

$= \frac{19.00+19.95}{2}$

$= \frac{38.95}{2}$

$= 19.475$

$\approx 19.50cm^3$

(c) Balanced chemical equation

$Na_2CO_{3\,(aq)} + 2HCl_{(aq)} \rightarrow Nacl_{(aq)} + Co_{2(g)} + H_2O_{(l)}$

(d) (i) Calculation for the Molarity of sodium carbonate.

Molarity of acid (Ma) = 0.1M

Volume of Acid (V_a) = $19.50cm^3$

Volume of base (Vb) = $20.00cm^3$

Molarity of base (Mb) =?

Mole ration acid = base

2:1

From $\frac{Mara}{Mb\,Vb} = \frac{na}{nb}$ where na is number of moles of acid

$\frac{0.1 \times 19.50}{mb \times 20.00} = \frac{2}{1}$ nb is the number of moles of base.

$Mb = \frac{0.1 \times 19.50 \times 1}{20.00 \times 2}$

$= \frac{1.95}{40}$

$= 0.04875$

Molarity of $Na_2CO_3 \approx 0.05M$

(ii) Concentration in g/dm^3 of sodium carbonate.

Concentration (g/dm^3) = Molarity ($moldm^{-3}$) x molar mass

= 0.05 x 106

= $5.3\ g/dm^3$

(iii) Calculation for the number of water of crystallization x in $Na_2CO_3xH_2O$

From the formula.

$\text{Molarity} = \frac{\text{conc.in } g/dm^3}{\text{molar mass}}$

$\text{Then, molar mass} = \frac{\text{conc.in } g/dm^3}{\text{Molarity}}$

$= \frac{14.3g/dm^3}{0.05Mol/dm^3}$

= 286g/mol

But molar mass = 286

$Na_2CO_3xH_2O = 286$

106 + 18x = 286

18x = 180

X = 10

∴ The number of water of crystallization in $Na_2CO_3.XH_2O = 10$

Practical 05

You are provided with

a: Solution KK containing 5.3g/dm^3 of A_2CO_3

b: Solution NN containing 0.1 M HCL per dm^3

c: Methyl orange indicator used.

Procedure

Put solution NN into the burette; pipette 20cm^3 of solution KK into a flask. Add two drops of methyl orange indicator. Titrate solution KK against solution NN until a colour change is observed. Repeat the procedure to obtain three more readings and record your results in a tabular form as shown below:-

(a) Table of results

Titration

Titration number	Pilot	1	2	3
Initial reading (cm^3)				
Final reading (cm^3)				
Titre volume (cm^3)				

(i) Complete the table and calculate the mean titre.

(ii) ________________ cm^3 of solution KK require _____________ cm^3 of solution NN for complete reaction.

(iii) What is the colour change?

(b) Write a balanced chemical equation of the reaction between solution KK and NN.

(c) (i) Calculate the Molarity of solution KK

(ii) Calculate the molar mass of solution KK

(iii) Calculate the atomic mass of element A

(iv) Identify and name element A.

(v) Write the formula of solution KK.

Solution

a) Table of results;

Titration number	Pilot	1	2	3
Initial reading (cm^3)	20.20	40.30	20.00	39.90
Final reading (cm^3)	0.00	20.20	0.00	20.00
Titre volume (cm^3)	20.20	20.10	20.00	19.90

$$\text{Mean titre} = \frac{20.10 + 20.00 + 19.90}{3}$$

$$= \frac{60.00}{3}$$

ii) $20.00cm^3$ of solution KK required $20.00cm^3$ of solution NN for complete reaction

iii) The colour changed from yellow to orange

b). Balanced chemical equation; $A_2CO_3 + 2HCl \rightarrow 2ACl + H_2O + CO_2$

c i) Molarity of solution KK

Applying the formula, $\frac{MaVa}{MbVb} = \frac{na}{nb}$, Then

$$\text{Molarity of base (Mb)} = \frac{MaVanb}{Vbna}$$

$$= \frac{0.1Moldm^{-3} \times 20.00cm3 \times 1}{20.00cm3 \times 2}$$

$$= 0.05moldm^{-3}$$

$$\therefore The\ Molarity\ of\ solution\ KK = 0.05moldm^{-3}$$

ii) Molar mass of base solution KK $= \frac{Conc.in\ gdm-3\ of\ KK}{Molarity\ of\ KK}$

$$= \frac{5.3gdm-3}{0.05Moldm-3}$$

$$= 106gmol^{-1}$$

$$\therefore The\ Molar\ mass\ of\ solution\ KK = 106gmol^{-1}$$

iii) Atomic mass of element A can be calculated as follows:

Since, Molar mass of A_2CO_3 = 106, then

$$A \times 2 + (12 + 48) = 106,$$

$$2A + 60 = 106 \text{(Subtracting 60 on both sides)}$$

$$2A = 46 \text{(Dividing by two on both sides), we get}$$

$$A = 23g$$

iv) Element A is most likely Sodium (Na)

v) Formula for base solution KK becomes Na_2CO_3

Practical 06

You are provided with the following:

(i) Solution D - Containing 6.90 g of $T_2\,CO_3$ per 0.50 dm^3 of solution.

(ii) Solution N - Containing 1.55 g of hydrochloric acid per 200 cm^3 of solution.

(iii) Phenolphthalein indicator solution.

PROCEDURE:

Put the acid solution in the burette. Pipette 20 cm3 (or 25 cm^3) of D into a titration flask. Add a few drops of phenolphthalein indicator. Titrate solutions D against the acid solution until an endpoint is reached.

Record your titration results in a table as shown below. Repeat the titration procedure until you obtain three or four other titre values.

a) Table of results (burette readings)

Titration	**Pilot**	**1**	**2**	**3**
Final reading/cm^3				
Initial reading/cm^3				
Volume used.cm^3				

The volume of the pipette used was………..cm^3.
The volume of the burette used was…………cm^3.
Summary: ………..cm^3 of solution N was the volume used.

b) The colour change at the end-point was from…………to……………….

c) The volume of acid solution for the above neutralization reaction was……………….cm^3

d) The balanced equation for the above neutralization reaction is:

$$T_2CO_3 + 2HCI \longrightarrow 2TCL + H_2O_2$$

Calculate:

(i) The molarity of acid solution N

(ii) The molarity of the base solution D

(iii) The molecular weight of T_2CO_3

(iv) The atomic mass of element T

(e) Element T is most probably ____________________

Solution

(a) Table of results (Burette readings)

Titration	Pilot	1	2	3
Final reading (cm^3)	19.20	19.10	19.00	18.90
Initial reading (cm^3)	0.00	0.00	0.00	0.00
Volume used (cm^3)	19.20	19.10	19.00	18.90

Governing equation: $\mathbf{HCl + T_2CO3 \rightarrow 2TCl + H_2O + CO_2}$

- Average volume of solution N (acid) $= \dfrac{\mathbf{19.10 + 19.00 + 18.90}}{\mathbf{3}}$

$= \dfrac{\mathbf{57.00}}{\mathbf{3}}$

$= \mathbf{19.00cm^3}$

- The volume of pipette used was $\mathbf{20.00cm^3}$
- The volume of burette used was $\mathbf{50.00cm^3}$
- Summary: **19.00cm3** of acid solution N was used

(b) The colour change at the end-point was from **pink** to **colourless**

(c) The volume of acid solution N used for complete neutralisation was $\mathbf{19.00cm^3}$

(d) (i) Molarity of acid solution N;

Given that, $1.55g \equiv 200cm3$, *then*

$?g \equiv 1000cm^3$ (Cross multiplication), we get

Conc. in gdm^{-3} $= \dfrac{\mathbf{1.55g \times 1000\cancel{cm3}}}{\mathbf{200\cancel{cm3}}}$

$= \mathbf{7.75gdm^{-3}}$

Therefore, molarity $= \frac{Conc.in\ gdm-3}{Molar\ mass\ of\ acid\ HCl}$

$= \frac{7.75\cancel{g}dm-3}{36.5\cancel{g}mol-1}$

= 0.2123

$\simeq$ **0.21Moldm^{-3}**

(ii) Molarity of base solution;

Applying the formula $, \frac{MaVa}{MbVb} = \frac{na}{nb}$, Then

Molarity of base (Mb) $= \frac{MaVanb}{Vbna}$

$= \frac{0.21Moldm-3 \times 19.00\cancel{cm3} \times 1}{20.00\cancel{cm3} \times 2}$

= 0.09975

$\simeq$ **0.1moldm^{-3}**

(iii) Molecular weight of T_2CO_3;

Given that 6.90g = 0.50dm3

? g = 1.0dm3,

Then we get $= \frac{6.90g \times 1.0dm3}{0.50dm3}$,

= **13.8gdm^{-3}**

Molecular weight of T_2CO_3 $= \frac{Conc.in\ gdm-3\ of\ T2CO3}{Molarity\ of\ T2CO3}$,

$= \frac{13.8}{0.1}$

= 138gmol^{-1}

(iv) Atomic mass of element T;

Since, Molecular weight of T_2CO_3 = 138, Then

$T \times 2 + (12 + 48) = 138$

$2T + 60 = 138$(Deducting 60 on both sides), then

$2T = 138-60$

$2T = 78$(Dividing by 2 on both sides), so

Atomic mass of T = 39

(e) Element **T** is most probably **Potassium**

Practical 07

You are provided with the following:

Solution AA containing 2.0g of Sodium hydroxide in 0.5dm^3 of the solution.

Solution BB containing 3.15g of hydrated oxalic acid $(COOH)_2.XH_2O$ in 0.25dm^3 of the solution

Phenolphthalein indicator.

Procedure:

Pipette $25cm^3$ or $20cm^3$ of solution AA into the conical flask. Add two drops of phenolphthalein indicator and titrate it against BB from the burette to the end point.

Note the reading of the burette.

Repeat the procedure to obtain three more readings and record your results in a tabular form as shown below.

Table of results

(a) (i) burette readings

Titration	**Pilot**	**1**	**2**	**3**
Final reading(cm^3)				
Initial reading (cm^3)				
Volume used (cm^3)				

(ii) Volume of pipette used was ……………………………cm^3

(iii) Determine the mean titre volume

(iv) ………………cm^3 of solution BB required …………………cm^3 of solution AA for complete neutralization.

(b) i. The colour change at the end point was from …………………………to ……………………………

ii. Write a balanced chemical equation for the reaction between AA and BB.

(c) Calculate the

i. Concentration of AA in mol dm^3

ii. Concentration of BB in mol dm^3

iii. Molar mass of BB

(d) Find the value of X in $(COOH)_2.XH_2O$

i. Concentration of AA in mol dm^3

ii. Concentration of BB in mol dm^3

iii. Molar mass of BB

(d) Find the value of X in $(COOH)_2.XH_2O$

Solution

(a) (i) Table of results.

Burette readings

Titration	Pilot	1	2	3
Final reading (cm^3)	12.70	25.20	37.70	12.50
Initial reading (cm^3)	0.00	12.70	25.20	0.00
Volume used (cm^3)	12.70	12.50	12.50	12.50

(ii) Volume of pipette used was **25.000cm³**

(iii)The mean titre volume = $\frac{12.50+12.50+12.50}{3}$

$= \frac{37.50}{3}$

$= 12.50cm^3$

(iv) **$12.50cm^3$** of solution BB required **$25.00cm^3$** of solution AA for complete neutralization.

(b) (i) The colour change at the end point was from **pink** to **colourless**

(ii) Balanced chemical equation for the reaction between AA and BB

$$2NaOH + H_2C_2O_4 \rightarrow Na_2C_2O_4 + H_2O$$

(c) (i) Concentration of AA in mol dm^3 = $\frac{Conc.in\ gdm-3}{Molar\ mass\ of\ AA}$

$= \frac{4.0\cancel{g}dm-3}{40\cancel{g}mol-1}$

$= 0.1Moldm^{-3}$

(ii) Concentration of BB in mol dm^{3},

Referring this relation; $\frac{MaVa}{MbVb} = \frac{na}{nb}$, Then,

Concentration of BB in $moldm^{-3}$ (Ma) $= \frac{MbVbna}{Vanb}$

$= \frac{0.1Moldm-3 \times 25\cancel{cm3} \times 1}{12.50\cancel{cm3} \times 2}$

$= 0.1Moldm^{-3}$

(iii) Molar mass of BB = $\frac{Concentration\ of\ hydrated\ oxalic\ acid\ in\ gdm-3}{Molarity\ of\ hydrated\ oxalic\ acid}$

$= \frac{12.6g\cancel{dm-3}}{0.1Mol\cancel{dm-3}}$

$= 126gmol^{-1}$

(d) Find the value of X in $(COOH)_2.XH_2O$

Since, $H_2C_2O_4.xH_2O$ $= 126gmol^{-1}$ Then,

$90 + 18x = 126$ (Deducting 90 on both sides)

$18x = 36$(Dividing by 18 on both sides), So

$x = 2$

Practical 08

1. You are provided with the following:

1.1 Solution AA prepared by diluting $100cm^3$ of 1M hydrochloric acid to $1000cm^3$ with distilled water.

1.2 Solution BB is sodium hydroxide

1.3 Phenolphthalein indicator Procedure

Pipette $20cm^3$(or $25cm^3$) of solution BB into a titration flask. Add two drops of POP indicator. Titrate solution BB against solution AA from the burette until a colour change is observed. Note the burette reading. Repeat the procedure to obtain three more readings. Record your results as shown below.

a) Table of results.

(i) Burette readings

Titration number	**Pilot**	**1**	**2**	**3**
Final readindem^3				
Initial readingem^3				
Volume used cm^3				

(ii) The volume of pipette used was ——cm^3

(iii) The colour change at the end point was from —— to ——

(iv) ——cm^3 of solution AA was required to neutralize—— cm^3 of solution BB.

v) Write a balanced chemical equation for the neutralization of sodium hydroxide by hydrochloric acid.

(c) Calculate the:

(i) Molarity of solution AA

(ii) Concentration in moles/dm^3 of solution BB

(iii) Concentration in g/dm^3 of solution BB

Solution

(a) (i) Table of results

Titration number	Pilot	1	2	3
Final reading(cm^3)	21.20	41.40	20.10	40.10
Initial reading(cm^3)	0.00	21.20	0.00	20.10
Volume used (cm^3)	21.20	20.20	20.10	20.00

$$\text{Average volume of acid solution} = \frac{20.20+20.10+20.00}{3}$$

$$= \frac{60.30}{3}$$

$$= \mathbf{20.10cm^3}$$

i) Volume of pipette used was **20.00cm^3**

ii) The colour change at the end-point was from **pink** to **colourless.**

iii) **20.10cm^3** of AA were required to neutralize **20.00cm^3** of BB.

b) Required equation; $NaOH + HCl \rightarrow NaCl + H_2O$

c) (i) From dilution formula **McVc =MdVd**, where **Mc** is Molarity of conc. Acid

Vc is Volume of conc. Acid

Md is Molarity of diluted acid and

Vd is final volume (volume of diluted acid)

Then we have Md=Mc×Vc/Vd

$=1\times100cm^3/1000cm^3$

$=0.1Moles/dm^3$

ii) Molarity of base (Mb);

This can be calculated using the following relationship:-

$$\frac{MaVa}{MbVb}=\frac{na}{nb},$$

where **ma** is molarity of acid,

va is volume of acid,

na is number of moles of acid

mb is molarity of base,

vb is volume of base,

nb is number of moles of base

Since mole ratio **na: nb** is 1:1,

Therefore **Mb** $= \frac{mavanb}{Vbna}$

$=0.1moles/dm^3\times20.10cm^3\times1/20.00cm^3\times1$

$\mathbf{=0.1moles/dm^3}$

iii).Concentration in g/dm^3 of solution BB;

From the formula, Molarity of base (**mb**) = conc.in gdm^{-3}/Molecular weight

Then, Concentration in g/dm^3 = Molarity × Molecular weight

$= 0.1\cancel{mole}/dm^3\times40g/\cancel{mole}$

$\mathbf{= 4.0g/dm^3}$

Practical 09

You are provided with the following solutions:
Solution WW containing 4.38 g of pure hydrochloric acid per dm^3 of solution Solution ZZ containing 14.30 g of hydrated sodium carbonate [$Na_2C0_3.XH_20$]
Methyl orange indicator
Procedure:
Put solution WW in the burette. Pipette $20cm^3$ (or 25 cm^3) of solution ZZ into a titration flask. Add about three to four drops of methyl orange indicator into the titration flask. Titrate solution WW against solution ZZ until the end point is reached. Note the burette reading. Repeat the procedure to obtain three more readings. Record your results as shown in the following Table.

a) Table of results

(i) Burette readings

Titration	Pilot	1	2	3
Final reading (cm^3)				
Initial reading (cm^3)				
Volume used (cm^3)				

ii) The volume of pipette used was……………………..cm^3

iii) The volume solution WW needed for complete neutralization was………………..

iv) The color change at the end point was from………………to…………………..

b) Write down a balanced chemical equation for the reaction between solution ZZ and WW.

c) Calculate the morality of

i) Solution WW

ii) Solution ZZ.

d) Calculate the value of x in the formula Na2CO_3.XH_2O

Solution

(i) Burette readings

Titration	Pilot	1	2	3
Final reading (cm^3)	21.00	41.90	20.80	41.60
Initial reading (cm^3)	0.00	21.00	0.00	20.80
Volume used (cm^3)	21.00	20.90	20.80	20.80

(ii) The volume of pipette used was $\underline{25\ cm^3}$

$$\text{Average volume of WW} = \frac{20.90+20.80+20.80}{3}$$

$$= \frac{62.50}{3}$$

$$= 20.833$$

$$\approx 20.83\ cm^3$$

The volume of sodium WW needed for complete neutralization was 20.83 cm^3

(iv) The color change at the end point was from yellow to orange.

(b) Balanced chemical equation for the reaction between solution ZZ and WW

$$Na_2CO_{3\,(aq)} + 2HCl_{(aq)} \longrightarrow 2Nacl_{(aq)} + CO_{2\,(g)} + H_2O_{(l)}$$

c) i) Morality of solution WW

$$\text{Morality} = \frac{\text{conc.in } g/dm^3}{\text{molar Mass}}$$

$$= \frac{4.38\ g/dm^3}{36.5\ g/mol}$$

$$= 0.12\ Mol/dm^3$$

ii) Morality of solution ~~ZZ~~

From relation,

$$\frac{Ma\,Va}{mbVb} = \frac{na}{nb}$$

Then, $$\frac{0.12\ x 20.83}{mb\ x\ \ 25} = \frac{2}{1}$$

where,

Ma = Molarity of acid

Va = Volume of acid

na = number of moles of acid

Mb = Molarity of base

Vb = Volume of base

nb = number of moles of base

$$Mb = \frac{0.12 \times 20.83}{25 \times 2}$$

$$= 0.049992$$

$\therefore$ Molarity($\cancel{ZZ}$) $\approx 0.05M$

d) Value of x in the formula (Na_2CO_3 x H_3O)

Given that: Conc. in/dm^3 of $Na_2CO_3.XH_2O = 14.30$

Then, from

$$\text{Molarity} = \frac{\text{conc. in g/dm}^3}{\text{Molecular Weight}}$$

$$0.05 = \frac{14.30}{\text{Molecular Weight}}$$

$$\text{Molecular Weight} = \frac{4.30}{0.05}$$

$$= 286 g/mol$$

But $286 = Na_2CO_3.XH_2O$

$$286 = 106 + 18x$$

$$286 - 106 = 18x$$

$$180 = 18x, (\text{divide by } 18)$$

$$\frac{180}{18} = \frac{18x}{18}$$

$$10 = x$$

$\therefore$ The value of x in the formular $Na_2CO_3.XH_2O = 10$

$\therefore x = 10$

Practical 10

You are provided with the following:

PP: Solution containing 3.65 g of HCl per dm^3 of the solution

VV: Solution containing 7.15 g of hydrated sodium carbonate ($Na_2CO_3.xH_2O$) in 0.5 dm^3 of the solution.

MO: Methyl orange indicator.

Questions:

(a) (i) Determine the average titre volume.

(ii) ___________ cm^3 of solution VV required __________ cm^3 of solution PP for complete reaction.

(iii) State one indicator other than methyl orange which would be suitable in this experiment and state Why do you think it is suitable.

(b) Predict the effect if each of the following conditions were applicable in this Experiment:

(i) The pipette used was not rinsed with sodium carbonate.

(ii) The air space at the burette tip was not removed before titration.

(c) Write a balanced chemical equation of the reaction between solution PP and VV.

(d) (i) Calculate the concentration of PP in moles/dm^3.

(ii) Find Molarity of solution VV.

(e) Deduce the value of x in $Na_2CO_3xH_2O$.

Solution

Table of results;

Titration	Pilot	1	2	3
Final reading (cm^3)	20.10	40.10	20.00	40.00
Initial reading (cm^3)	0.00	20.10	0.00	20.00
Titre volume (cm^3)	20.10	20.00	20.00	20.00

(a) (i) Average titre volume $= \frac{20.00+20.00+20.00}{3}$

$= \frac{60.00}{3}$

$= \mathbf{20.00cm^3}$

(ii) $\mathbf{20.00cm^3}$ of solution VV required $\mathbf{20.00cm^3}$ of solution PP for complete neutralization

(iii) POP indicator would be suitable indicator other than MO the reaction is btn strong acid against strong base; so either of the two indicators would be suitable

(b) (i) If pipette was not rinsed with base solution might affect the concentration of base solution, usually we rinse the pipette but in either case, it is to make sure no water is left in the apparatus which would dilute titration resulting to errors in readings. Normally the pipette is rinse with water and then the solution to be titrated. If there is still extra water in the pipette and the solution was sucked, it might decrease the concentration of the solution (more water).So if the pipette is wet; rinse it with the sample being tested.

(ii) If the air space at the burette tip was not removed before titration might lead to errors, air space will be filled first before dropping on the acid solution (which will deduct a few volumes from the reading in the burette). The scale on the burette considers the area in the tip of the burette, so if there was no acid and the titration was done to endpoint the result will overstate the amount of acid you really used for the titration. Burette measurements are very precise so air bubbles will interfere this exact volume of the titrant (acid)

The measure of volume used in the titration will be inaccurate, because there will appear to be more titrate used than has actually been dispensed and the air space will add error to the measurement.

(c) Balanced chemical equation; $\mathbf{2HCl + Na_2CO_3 \rightarrow 2NaCl + H_2O + CO_2}$

(d) (i) Concentration of acid HCl in $moldm^{-3}$;

Since, Molarity $= \frac{conc.in\ g/dm3}{Molar\ mass}$, then

$= \frac{3.65\cancel{g}/dm3}{36.5\cancel{g}/mole}$

$= \mathbf{0.10moldm^{-3}}$

ii) Molarity of base solution (VV) Na_2CO_3;

From the relation; $\frac{MaVa}{MbVb} = \frac{na}{nb}$ Then,

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

$$= \frac{0.1moldm-3 \times 20.00\cancel{cm3} \times 1}{20.00\cancel{cm3} \times 2}$$

$$= 0.05moldm^{-3}$$

e) The value of x in $Na_2CO_3.xH_2O$

From;

Molarity = $\frac{Conc.in\ gdm-3}{Molecular\ weight\ of\ hydrated\ Na2CO3}$ 'then

Molecular weight of hydrated Na_2CO_3 = $\frac{Conc.in\ gdm-3}{Molarity}$

$$= \frac{14.3gdm-3}{0.05Moldm-3}$$

$$= 286gmol^{-1}$$

So, $Na_2CO_3.xH_2O$ = 286

106 + 18x = 286 (deducting 106 on both sides), we have

18x = 180 (dividing by 18 on both sides), we have

x = 10

Practical 11

You are provided with the following:

Solution M containing 9.0 g of H2X per of the solution

Solution N containing 4.91 g of sodium hydroxide of the solution

Solution P is phenolphthalein indicator.

Procedure:

Put solution M into the burette. Pipette 25 of solution N into a titration flask. Put two to three drops of P into the titration flask. Titrate solution M from the burette against solution N in the titration flask until a color change is observed. Note the burette reading. Repeat the procedure to obtain three more readings. Record your results as shown in the following Table.

Results

Table 1: Burette readings

Titration	Pilot	1	2	3
Final reading (cm^3)				
Initial reading (cm^3)				
Volume used (cm^3)				

a) Give the volume of the pipette used.

b) Give the volume of solution M needed for complete neutralization of solution N

c) Tell the color change of the indicator at the end point of the titration.

d) Write the balanced chemical equation for the reaction between solution M and N

e) Calculate the

i) Morality of solution M

ii) Molar mass of H_2X

iii) Mass of X in H_2X

Solution

Burette readings

Titration	Pilot	1	2	3
Final reading (cm^3)	12.50	24.90	37.20	12.20
Initial reading (cm^3)	0.00	12.50	24.90	0.00
Volume used (cm^3)	12.50	12.40	12.30	12.20

a) The volume of pipette used was 20 cm^3

b) The volume of solution M need for complete neutralization of solution N was:-

$$= \frac{12.40 + 12.30 + 12.20}{3}$$

$$= 12.30\ cm^3$$

c) The color change of the indicator at the end point of the titration was form pink to colorless.

d) Balanced chemical equation for the reaction between solution M and N

$$H_2X_{(ag)} + 2NaoH_{(aq)} \longrightarrow Na_2X_{(aq)} + 2H_2O_{(l)}$$

e) i Molarity of solution M (Ma)

- We must first the Molarity of N i.e. Molarity of solution N

$$= \frac{\text{conc. in } g/dm^3}{\text{Molar Mass of N}}$$

$$= \frac{4.91\ g\ dm^{-3}}{40\ gmol^{-1}}$$

$$= 0.12275\ M$$

$$\approx 0.123\ M$$

From the relation

$$\frac{MaVa}{mbVb} = \frac{na}{nb}$$

$$\frac{Ma \times 12.30}{0.123 \times 20} = \frac{1}{2}$$

$$Ma = \frac{0.123 \times 20 \times 11}{2.30 \times 2}$$

$$= 0.1\ M$$

$\therefore$ Molarity of solution M (Ma) = 0.1M

ii Molar Mass of H_2X

But, Molar Mass

$$= \frac{\text{conc. in } g/dm^3}{\text{Molarity } (Mol\ dm^{-3})}$$

$$= \frac{9.0\text{g dm}^{-3}}{0.1 \text{ mol dm}^{-3}}$$

$$= 90\text{g/Mol}$$

iii Mass of X in H_2X

Since, Molar Mass of

$H_2X = 90$
$2 + x = 90$

$x = 90 - 2$

Then, Mass of $x = 88$g.

Practical 12

You are provided with the following:

1.1 Solution X containing 1.55 g of hydrated sodium carbonate ($Na_2CO_3.nH_20$) per 250 cm^3 of the solution.

1.2 Solution Y prepared by diluting 250 cm^3 of 0.4 M hydrochloric acid to 1000 cm^3 of the solution with distilled water.

1.3 Methyl orange indicator labelled Z.

Procedure:

Put solution Y into the burette. Pipette 20 cm^3 (or 25 cm^3) of solution X into a titration flask.

Put two to three drops of Z into the titration flask. Titrate solution Y from the burette against solution X in the titration flask until a colour change is observed. Note the burette reading. Repeat the procedure to obtain three more readings and record your results in a table as shown below.

(a) Table of results.

(i) Burette readings.

Titration number	**Pilot**	**1**	**2**	**3**
Final reading (cm^3)				
Initial reading (cm^3)				
Volume used (cm^3)				

(ii) The volume of pipette used was__________ cm^3.

(iii) The colour change at the end point was from _________ to ___________.

(iv) Summary:

______________cm^3 of solution Y required__________ cm^3 of solution X for complete reaction.

(b) Write a balanced chemical equation for the reaction between solutions X and Y.

(c) Calculate the

(i) Molarity of solution Y.

(ii) Molarity of solution X

(iii) Mass of anhydrous sodium carbonate.

(iv) The mass of water of crystallization in 1.55 g hydrated sodium carbonate.

Solution

a) (i) Burette readings

Titration number	Pilot	1	2	3
Final reading (cm^3)	25.20	25.10	25.00	49.90
Initial reading(cm^3)	0.00	0.00	0.00	25.00
Volume used(cm^3)	25.20	25.10	25.00	24.90

Average volume used = $\frac{25.10+25.00+24.90}{3}$

$= \frac{75.00}{3}$

$=$ **$25.00cm^3$**

(ii) The volume of pipette used was **$25.00cm^3$**

(iii) The colour change at the end-point was from **<u>yellow</u>** to **<u>orange</u>**

(iv) Summary:

$25.00cm^3$ of solution **Y** required **$25.00cm^3$** of solution **X** for complete reaction

b) Balanced chemical equation; **$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$**

c) (i) Calculation for the molarity of acid solution **Y**;

By using dilution formula, $Mc \times Vc = Md \times Vd$, Where Mc is molarity of Conc. acid = $0.4Moldm^{-3}$

Vc is volume of conc. acid = 250cm3

Md is molarity of diluted acid and =?

Vd is final volume or diluted volume = 1000cm3

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

$= \frac{0.4 \times 250}{1000}$

Therefore , Molarity of diluted acid Y (Md) = **$0.1Moldm^{-3}$**

ii) Molarity of base solution X;

Applying the formula , $\frac{MaVa}{MbVb} = \frac{na}{nb}$, Then

Molarity of base (Mb) = $\frac{MaVanb}{Vbna}$

$= \frac{0.1 \times 25.00 \times 1}{25.00 \times 2}$

= **$0.05Moldm^{-3}$**

iii) Mass of anhydrous Na_2CO_3;

From the relation, **Molarity** $= \frac{Conc.in\ gdm-3}{Molecular\ weight}$, Then

Conc. in gdm^{-3} = Molarity × Molecular weight

$= 0.05\cancel{mol}dm^{-3} \times 106g\cancel{mol}^{-1}$

$= 5.3gmol^{-3}$

From the relation;

Molarity $= \frac{Conc\ .in\ gdm-3}{Molar\ mass\ of\ hydrated\ Na_2CO_3}$, then

Molar mass of hydrated $Na_2CO_3 = \frac{Conc.in\ gdm-3\ of\ hydrated\ Na_2CO_3}{Molarity}$

$= \frac{6.2}{0.05}$

$= 124gmol^{-1}$

Since, $Na_2CO_3.nH_2O = 124$

Then $106 + 18n = 124$(Deducting 106 on both sides), we have

$18n = 18$ (Dividing by 18 on both sides)

iv) Therefore n = 1, and the mass of water of crystallization is **18g**

Practical 13

Solution P contains 4.0g of sodium hydroxide solid per litre of solution.
Solution Q contains 12.6g of hydrated oxalic acid $H_2C_2O_4.XH_2O$ Solid per litre of solution

Put the acid solution in the burette and titrate equal portions of the base solution using phenolphthalein indicator provided. The following procedure should help you in recording and processing of your experimental results.

(a) Table of results (burette readings)

Titration No.	Pilot	1	2	3
Final reading				
Initial reading				
Volume used				

(b) Volume of the pipette actually used………..cm³.

(c) The colour change at the end / point was from……………..to……………………

(d) The volume of the acid solution Q needed for complete neutralization was……….cm³.

(e) Given the equation for the reaction:

$H_2C_2O_4 + 2NaOH \longrightarrow Na_2C_2O_4 + H_2O$

Calculate:-

(i) The molarity of the acid solution Q.

(ii) Concentration of acid solution Q in g/dm³.

(iii) The value of X.

Solution

(a) Table of results;

Titration number	Pilot	1	2	3
Final reading (cm^3)	10.20	20.30	30.30	40.20
Initial reading (cm^3)	0.00	10.20	20.30	30.30
Volume used(cm^3)	10.20	10.10	10.00	9.90

Mean titre value $= \frac{10.10 + 10.00 + 9.90}{3} = \frac{30}{3} = \mathbf{10.00cm^3}$

b) Volume of pipette actually used = $\mathbf{20.00cm^3}$

c) The colour change at the end-point was from **pink** to **colourless**

d) The volume of acid solution Q needed for complete neutralization was $\mathbf{10.00cm^3}$

e) (i) Molarity of acid solution Q can be calculated from the formula below:-

From the relation, **Molarity** $= \frac{Conc.in\ gdm-3\ of\ NaOH}{Molar\ mass\ of\ NaOH}$

$= \frac{4.0gdm-3}{40gmol-1}$

$= \mathbf{0.1Moldm^{-3}}$, Then by applying this formula

$\frac{MaVa}{MbVb} = \frac{na}{nb}$,

Molarity of acid solution Q (**Ma**) $= \frac{MbVbna}{Vanb}$

$= \frac{0.1Moldm-3 \times 20.00\cancel{cm3} \times 1}{10.00\cancel{cm3} \times 2}$

$= \mathbf{0.1Moldm^{-3}}$

ii) Conc. of acid solution Q in gdm-3 = Molarity of acid × Molar mass of anhydrous acid $H_2C_2O_4$

$= 0.1\cancel{mol}dm^{-3} \times 90g\cancel{mol^{-1}}$

$= \mathbf{9gdm^{-3}}$

iii) The value of *x* can be calculated as follows:-

Since, Molarity $= \frac{Conc.in\ gdm-3\ of\ hydrated\ Oxalic\ acid}{Molecular\ weight\ of\ hydrated\ Oxalic\ acid}$,

Then, Molecular weight of hydrated oxalic acid $= \frac{Conc.in\ gdm-3\ of\ hydrated\ Oxalic\ acid}{Molarity\ of\ Oxalic\ acid}$

$H_2C_2O_4.xH_2O = \frac{12.6}{0.1}$

$90 + 18x = 126$ (Deducting 90 on both sides)

$18x = 36$ (dividing by 18 on both sides), so

$\mathbf{x = 2}$

Alternatively,

You may apply this formula;

$\frac{mass\ of\ anhydrous\ acid}{mass\ of\ hydrated\ acid} = \frac{Molar\ mass\ of\ anhyrous\ acid}{Molar\ mass\ of\ hydrated\ acid}$

i.e. $\frac{9.0}{12.6} = \frac{90}{90+18x}$ (Cross multiplication)

$9(90 + 18x) = 12.6 \times 90$

$810 + 162x = 1134$ (Deducting 810 on both sides),

$162x = 324$ (Dividing by 162 on both sides),

$x = 2$

Practical 14

You are provided with the following solutions:

H: Containing 6.3 g of hydrated oxalic acid, $(COOH)_2.XH_2O$ *in* $1dm^3$ *of the solution.*

M: Containing 1.4 g of potassium hydroxide in 0.5 dm^3 of the solution phenolphthalein indicator.

Questions

a) Titrate the aid (in a burette) against the base (in a conical flask) using two drops of the indicator and obtain three titre values.

b) (i) ………………… cm^3 of M required ……………………cm^3 of **H** for complete reaction.

(ii) The color change at the end point was from ………… to……………………

(iii) Is the use of methyl orange indicator in this experiment as suitable as the use of phenolphthalein? Give a reason for your answer.

c) Showing your procedures clearly, determine the value of X in the formula $(COOH)_{2(aq)} + 2KOH_{(aq)} \rightarrow (COOK)_{2(aq)} + 2H_2O_{(l)}$.

Solution

Solutions:

H = N$(COOH)_2$ x H_2O

M = KOH

Indicator phenolphthalein

Acidic

6.3g → $1dm^3$

Base

1.4g → $0.5dm^3$

a)

PILOT	PILOT	1	2	3
Final volume (cm^3)	25.00	25.00	25.00	25.00
Initial volume (cm^3)	00.00	00.00	00.00	00.00
Volume	25.00	25.00	25.00	25.00

b) (i) $25cm^3$ *of M required* $25cm^3$ of H for complete reaction.

(ii) Pink to yellow

(iii) It's not suitable for methyl orange because weak acid is merely detecting color change for the small drop. It needs huge drops addition to detect color that can cause over exceeding and point.

c) Solution

Morality = $\frac{Conc.}{Molar\ Mass}$

Mr of KOH $= {}^{40g}/_{mol}$

Conc. = of KOH

$1.4\text{g} \rightarrow 0.5dm^3$

$\text{X} \leftarrow 1dm^3$

$\text{X} = \frac{1.4g}{0.5dm^3} = {2.8}/_{dm^3}$

Morality of NaOH (B) = $\frac{{2.8g}/_{dm^3}}{{40g}/_{mol}} = 0.07M$

From molar ration

$M_aV_an_b = M_aV_an_b$

$M_a = \frac{M_a\ x\ V_a\ x\ n_a}{V_a\ x\ n_b}$

$But\ n_a = 1,\ n_b = 2$

Ma = $\frac{0.07M\ x\ 25cm^3\ x\ 1}{25cm^3\ x\ 2} = 0.014M$

But

Mr = $\frac{Conc.}{Molarity}$

Mr = $\frac{{6.3g}/_{dm^3}}{0.014{}^{mol}/_{dm^3}} = {450g}/_{mol}$

But

$(COOH).\ X(H_2O)$

$45 + \text{X}\ (18) = 450$

$\text{X}\frac{(18)}{18} = \frac{450}{18} = 22.5$

$\therefore X = 22.5$

Practical 15

You are provided with the following:

i. Solution W containing 3.00g of acetic acid (CH_3CCOOH) per 0.5dm^3 of solution
ii. Solution Q containing 2.20g of impure sodium bicarbonate per 0.25dm^3
iii. Methyl orange indicator solution.

Put the acid solution in the burette. Pipette 20cm^3 (or 25cm^3) of solution Q into a titration flask. Add few drops of MO indicator. Titrate the sodium hydrogen carbonate solution against the acid solution until an end-point is reached. Record your titre results a table. Repeat the titration to obtain three more readings.

a) Table of results (Burette readings)

Titration	Pilot			
Final reading(cm^3)				
Initial reading (cm^3)				
Volume used (cm^3)				

Volume of pipette used was .... cm^3

(b) The colour change at the end point was from —— to ——

(c) The volume of acid solution W needed for complete neutralization was .... cm^3

(d) The balanced chemical equation the above neutralization reaction is

$NaHCO_3 + CH_3COOH \rightarrow CH_3COONa + H_2O + C0_2$

Calculate:-

i. The molarity of the acid solution W
ii. The molarity of the base solution Q
iii. The concentration of $NaHCO_3$ in solution q in g/dm3.

(e) The impurity in the sodium hydrogen carbonate does not react with the acetic acid. Calculate the percentage by weight of the unreactive material (impurity) in the sodium bicarbonate solution.

Solution

(a) Table of results:

Titration	Pilot	1	2	3
Final reading (cm^3)	20.40	40.70	20.20	40.30
Initial reading (cm^3)	0.00	20.40	0.00	20.20
Volume used (cm^3)	20.40	20.30	20.20	20.10

So, Average volume of acid used $= \frac{20.30 + 20.20 + 20.10}{3}$

$= \frac{60.60}{3}$

$= \mathbf{20.20cm^3}$

Volume of pipette used was **20.00cm³**

b) The colour change at the end-point was from **yellow** to **orange**

c) The volume of acid solution needed for complete neutralization was **20.20cm³**

d) Given that, $\mathbf{NaHCO_{3\,(aq)} + CH_3COOH_{\,(aq)} \rightarrow CH_3COONa_{\,(aq)} + H_2O_{\,(l)} + CO_{2\,(g)}}$

(i) Molarity of acid solution; Given that 3.0g are in 0.5dm3

i.e. $3.0g \equiv 0.5dm^3$

$? \equiv 1.0dm3$

Then applying cross multiplication, we have 3.0g ×1.0dm3/ 0.5dm3 = 6.0g/dm^3

Therefore by using the formula,

Molarity of acid = conc.in gdm^{-3}/molecular weight

= 6.0gdm^{-3}/60gdm^{-3}

= 0.1moldm^{-3}

(ii) Molarity of base solution; from the relation

Mava/mbvb =na/nb,

Then, molarity of base (Mb) = Mavanb / Vbna

= 0.1moldm^{-3}× 20.20cm3×1 / 20cm3×1

= 0.101

≃ 0.1moldm^{-3}

(iii) Concentration of NaHCO3 in solution Q in g/dm^3;Now from the formula,

Molarity = Conc. in gdm^{-3} / molecular mass,

So, Conc. in gdm^{-3} = molarity of base × Molecular mass

= 0.1~~mol~~dm^{-3} ×84g~~mol^{-1}~~

= 8.40gdm^{-3}(pure material)

e) Percentage of unreactive material (impurity) in base solution;

Given that 2.20 are in 0.25dm3

ie. 2.20g ≡ 0.25dm3

? ≡ 1.0dm^{-3}, by cross multiplication we get

= 2.20g×1.0dm3 / 0.25dm^{-3}

= 8.80gdm^{-3}(impure material)

But percentage (%) of impurity

$$= \frac{\boldsymbol{conc.in\ gdm-3\ of\ impure\ material - conc.in\ gdm-3\ of\ pure\ material}}{\textbf{Conc.in gdm}-\textbf{3 of impure materia}} \times 100$$

$$= \frac{\boldsymbol{8.80gdm-3 \quad - \quad 8.40gdm-3}}{\textbf{8.80gdm}-\textbf{3})} \times 100$$

= 4.55%

Practical 16

You are provided with the following:

(i) Solution E – containing 3.65 g of hydrochloric acid per dm^3 of solution.

(ii) Solution K – containing 3.575 g of pure hydrated sodium carbonate, Na_2CO_3. X H_2O per 0.25 dm^3 of solution.

(iii) Methyl orange indicator solution.

Put the acid solution in the burette. Pipette 20 cm^3 (or 25 cm^3) of solution K into a titration flask. Add a few drops of methyl orange indicator. Titrate this base solution against the acid solution until an end-point is reached. Record your titre results. Repeat the titration and record your titre results in a tabular form as follows:

(a) Table of titre results:
Volume of pipette used was ___________ cm^3.

Titration	**Pilot**	**1**	**2**	**3**
Final reading / cm^3				
Initial reading / cm^3				
Volume used / cm^3				

(b) The colour change at the end-point was from ___________ to __________.

(c) The Volume of acid solution E needed for complete neutralization was ________ cm^3.

(d) Write down the balanced equation for the reaction.

(e) Calculate:
(i) The molarity of acid solution E
(ii) The molarity of base solution K
(iii) The concentration of Na_2CO_3 in solution K in g/dm^3.

(f) What is the value of x?

Solution

(a) Table of results:

Volume of pipette used was **25.00cm³**

Titration	Pilot	1	2	3
Final reading (cm^3)	25.10	25.00	25.00	25.00
Initial reading (cm^3)	0.00	0.00	0.00	0.00
Volume used (cm^3)	25.10	25.00	25.00	25.00

$$\text{Average titre value} = \frac{\mathbf{25.00 + 25.00 + 25.00}}{\mathbf{3}}$$

$$= \frac{\mathbf{75.00}}{\mathbf{3}}$$

$$= \mathbf{25.00cm^3}$$

b) The colour change at the end-point was from **yellow** to **orange**

c) The volume of acid solution E needed for complete neutralization was **25.00cm³**

d) Balanced equation; $\mathbf{Na_2CO_{3\,(aq)} + 2HCl_{(aq)} \rightarrow 2NaCl_{(aq)} + H_2O_{(l)} + CO_{2\,(g)}}$

e) (i) Molarity of acid solution E;

It is known that Molarity = conc. in gdm-3/molecular weight

$$= 3.65gdm^{-3}/36.5gmol^{-1}$$

$$= \mathbf{0.10moldm^{-3}}$$

ii) Calculation for the molarity of base solution K;

$$\text{From the relation: } \frac{mava}{mbvb} = \frac{na}{nb}$$

Then we have, molarity of base (Mb) = $\frac{mavanb}{vbna}$

$= 0.10moldm^{-3} \times 25.00\cancel{cm^3} \times 1/25.00\cancel{cm^3} \times 2$

$= \mathbf{0.05\ moldm^{-3}}$

iii) Conc. of Na_2CO_3 in solution K in gdm^{-3};

= Molarity × Molecular mass

$= 0.05\cancel{mol}dm^{-3} \times 106g\cancel{mol^{-1}}$

$= \mathbf{5.3gdm^{-3}}$

f) Calculating value of x;

Given that 3.575g are in $0.25dm^3$

i.e. 3.575g≡ 0.25dm3

?g ≡ $1.0dm^3$

Then we have, by cross multiplication = $3.575g \times 1.0dm^3/0.25dm^3$

$=14.30gdm^{-3}$(hydrated mass of Na_2CO_3),

Therefore by using the relation;

$$\frac{mass\ conc.in\ gdm{-3}\ of\ anhydrous\ Na_2CO_3}{Molar\ mass\ of\ anhydrous\ Na_2CO_3} = \frac{mass\ Conc.in\ gdm{-3}\ of\ hydrated\ Na_2CO_3}{Molar\ mass\ of\ hydrated\ Na_2CO_3}$$

$$\frac{5.3}{106} = \frac{14.3}{106+18x}$$

Then by cross multiplication we get,

$\Rightarrow 5.3(106+18x) = 106 \times 14.30$

$\Rightarrow 561.80 + 95.40x = 1515.80$

$\Rightarrow 95.40x = 1515.80 - 561.80$

$\Rightarrow 95.4x/95.4 = 954.0/95.4$

$\Rightarrow x = 10$

Alternatively;

Molarity = conc. in gdm^{-3}/Molecular weight of hydrated Na_2CO_3

So, Molecular weight = Conc. in gdm^{-3}/ Molarity

= 14.3/0.05

$=286gmol^{-1}$

So, $Na_2CO_3.XH_2O = 286$

106+18X = 286 (Deducting 106 on both sides)

18x = 286 − 106

18x/18 = 180/18

X = 10

Practical 17

You are provided with the following solutions:

1.1 Solution P containing 28.60 g per litre of impure sodium carbonate.

1.2 Solution Q containing 0.20 mole of hydrochloric acid in a litre of solution.

1.3 Methyl orange as an indicator.

Procedure

Put the acid solution in a burette. Pipette 25 cm^3 (or 20 cm^3) of P into a titrating flask. Add a few drops of methyl orange indicator in the titrating flask containing solution P. Titrate solution P against the acid solution, until the end point is reached. Repeat this procedure until three titre values are obtained and record your titration results in a tabular form as shown below.

(a) Table of results:

TITRATION	PILOT	1	2	3
FINAL READING (cm^3)				
INITIAL READING (cm^3)				
VOLUME USED (cm^3)				

(i) Volume of pipette used..cm^3.

(ii) The mean titre is ....cm^3.

(iii) Summary:

......................cm^3 of solution P required ....cm^3 of solution Q for complete reaction.

(b) Write balanced equation for the above neutralization reaction.

(c) Calculate the molarity of P

(i) In moles per litre

(ii) In grams per litre.

(d) (i) Calculate the amount of impurity in g per litre.

(ii) If this impurity was due to water of crystallization in the salt, calculate the number of moles of water in one mole of sodium carbonate crystals.

Solution

(a) Table of results;

Titration	Pilot	1	2	3
Final reading (cm^3)	20.10	40.10	20.00	40.00
Initial reading(cm^3)	0.00	20.10	0.00	20.00
Volume used(cm^3)	20.10	20.00	20.00	20.00

i) Volume of pipette used was **20.00cm3**

ii) The mean titre is $= \frac{20.00+20.00+20.00}{3}$

$$= \frac{60.00}{3}$$

$$\underline{= 20.00cm^3}$$

iii) Summary:

$\underline{20.00cm^3}$ of solution P required $\underline{20.00cm^3}$ of solution Q for complete reaction.

b) Balanced chemical equation; $Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$

c) (i) Molarity of base (P); From the relation $MaVa/MbVb = na/nb$

Then Molarity of base (Mb) $= mavanb/vbna$

$$= 0.20moldm-3 \times 20.00\cancel{cm3} \times 1/_{20.00\cancel{cm3}} \times 2$$

$$= \mathbf{0.10mldm^{-3}}$$

d) (i) Amount of impurity in g/litre;

Given that amount of pure Na_2CO_3 = 10.60g/litre and

The amount of impure Na_2CO_3 = 28.60g/litre

Thus, the amount of impurity in g/litre may be calculated as follows; = Amount of impure − Amount of pure = 28.60g/litre − 10.60g/litre

(Amount of impurity in g/litre) = 18.00g/litre

ii) Number of moles of water of crystallization in one mole of Na_2CO_3;

By referring this relation,

$$\frac{Amount\ of\ pure\ Na2CO3\ in\ glitre{-1}}{Amount\ of\ impure\ Na2CO3\ in\ glitre{-1}} = \frac{Molecular\ mass\ of\ pur\ Na_2CO_3}{Molecular\ mass\ of\ impure\ Na_2CO_3}$$

$$\frac{10.60}{28.6} = \frac{106}{106+18n}$$

So, $\Rightarrow 10.60(106 + 18n) = 28.6 \times 106$

$\Rightarrow 1123.60 + 190.80n = 3031.60$

$190.80n = 3031.60 - 1123.60$

$190.80n = 1908.00$(dividing by 190.80 on both sides)

$$\frac{190.80n}{190.80} = \frac{1908.00}{190.80}$$

$$\mathbf{n = 10}$$

(B) Rate of chemical reaction with equilibrium

Practical 18

You are provided with the following materials

TT: A solution of 0.13M $Na_2S_20_3$ (Sodium thiosuphate)

HH: A solution of 2MHC1;

Distilled water:

Stopwatch

Procedure:

i) Using 10cm^3 measuring cylinder. Measure 20cm^3 of solution TT and put into 100 cm^3 beaker.

ii) Use different measuring cylinder to measure 10cm^3 of HH and pour it into the beaker containing solution TT. Immediately start the stop watch. Swirl the beaker twice.

iii) Place the beaker with contents on top of a piece of paper marked X

iv) Look down vertically through the month of the beaker so as to see the cross at the bottom of the beaker. Stop the clock when the letter X is invisible.

v) Record the time taken for the letter X to disappear completely.

vi) Repeat the experiment as shown in table 1.

vii) Record your results in tabular form as shown in table 1.

Table 1: Table of results

Exp.No.	Vol. of HH (cm^3)	Vol. of TT (cm^3)	Vol. of Distilled water (cm^3)	Time (sec)	$\frac{1}{t}$ (s^1)
1	10	20	0		
2	10	15	5		
3	10	10	10		
4	10	5	15		

Questions:

a) Complete filling the table of results (Table 1)

b) Write a balanced equation for reaction between TT and HH

c) What is the reaction product which causes the solution to could the letter X?

d) How was the factor of concentration varied in this experiment?

e) Plot a graph of 1/t against the volume of the thiosulphate.

f) Use the graph to explain how variation of concentration affects the rate of chemical reaction.

Solution

b) Balanced equation for the reaction between TT and HH

$$Na_2S_2O_{3(aq)} + 2HCl_{(aq)} \rightarrow 2NaCl_{(aq)} + H_2O_{(l)} + S_{(s)} + SO_{2(g)}$$

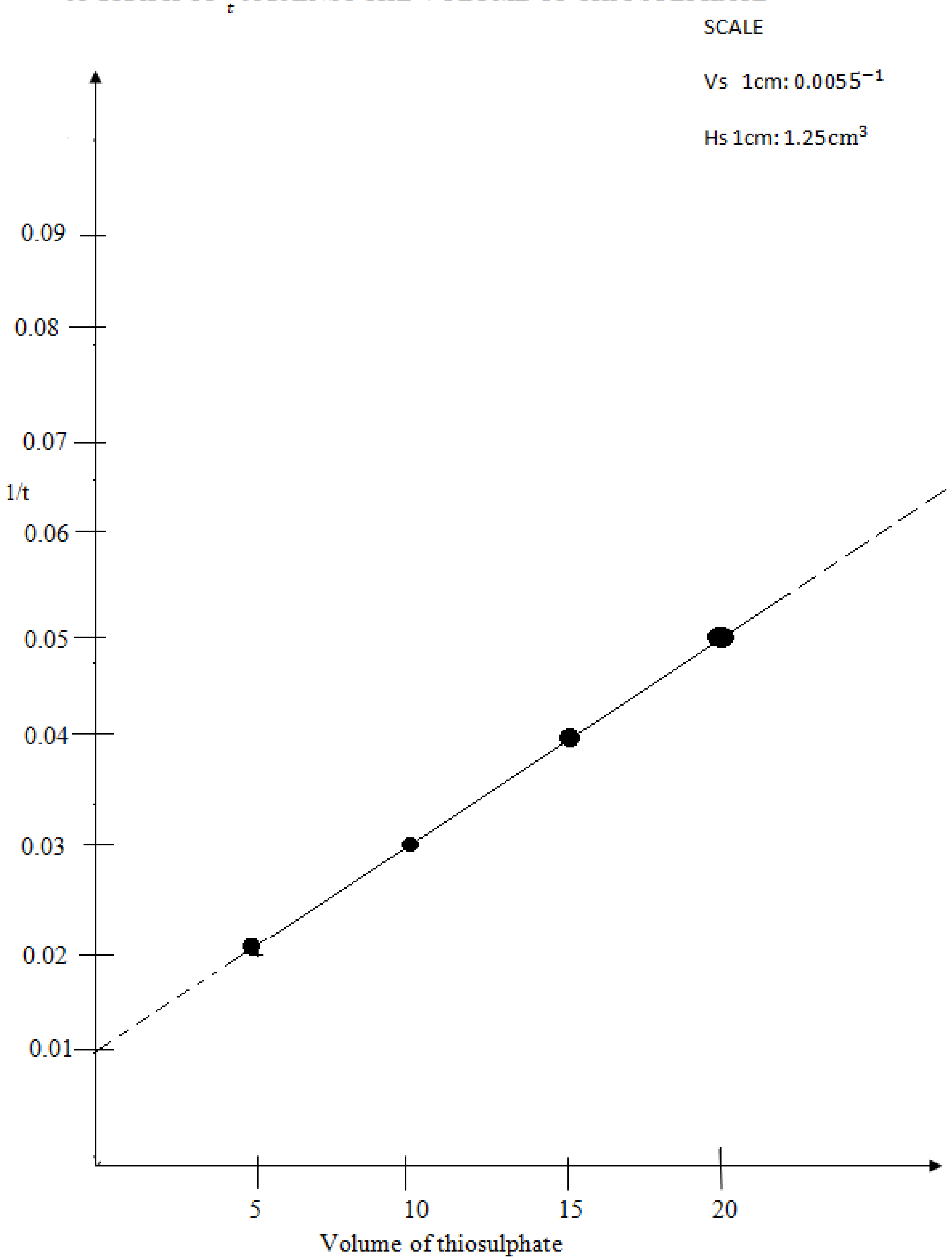
c) The reaction which causes the solution to cloud the letter X was sulphur (i.e. predicated sulphur caused the solution to cloud letter X)

a) Table 1: table of results

Exp.No.	Vol. of HH (cm^3)	Vol. of TT (cm^3)	Vol. of Distilled water (cm^3)	Time (sec)	$\frac{1}{t}$ (s^1)
1	10	20	0	20	0.05
2	10	15	5	24	0.04
3	10	10	10	34	0.03
4	10	5	15	50	0.02

d) The factor of concentration varied in this experiment in such a way that as concentration of sodium thiosuolphate decreases the rate of chemical reaction also decreases or as concentration increases the rate also increases.

e) A GRAPH OF $\frac{1}{t}$ AGAINST THE VOLUME OF THIOSULPHATE



f) As the concentration of sodium thiosulphate was decreased, the rate of chemical reaction was also decreased and or as the concentration increases, the rate of reaction also increases.

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Practical 19

You are provided with the following materials:-

Al: A solution of 0.2m, $Na_2S_20_3$

A2: A solution of 0.1MHC1

Distilled water

Stop watch

Procedure:-

i) Using $50cm^3$ measuring cylinder measure $30cm^3$ of solution Al and put it into $250cm^3$ beakers. Using the same cylinder add $20cm^3$of distilled water in the beaker containing Al.

ii) Using the same cylinder, measure $50cm^3$ of solution A2 and pour it into the beaker con training solution A1 and immediately start the stop watch. Stir the beaker twice and place it with the contents on top of a piece of paper marked X using ball pen.

iii) Look down vertically through the mouth of beaker so as to see the cross x at the bottom of beaker. Stop the clock when the cross x is invisible.

iv) Record the times taken for the cross X to disappear completely.

v) Repeat the experiment as shown in the table 1 below

vi) Record your results in tabular form as indicated

Table 1. Results

Exp.No	Vol of A2(cm^3)	Vol of A1 (cm^3)	Vol of distilled water (cm^3)	Conc.Of A1 in (mols dm-3)	Time taken for the cross to dis (t) (sec)	1/t (sec^{-1})
1	50	30	20			
2	50	25	25			
3	50	20	30			
4	50	15	35			
5	50	10	40			

Questions:-

a) Complete filling the table of results (Table 1) showing your working for the fifth column (i.e. cone, of A1 in $molsdm^{-3}$).

b) Write a balanced equation for the reaction between A1 and A2. Simplify the balanced equation into a net ionic equation.

c) Briefly explain the smell and colour observed as the reaction takes place

d) Plot a graph of against cone, (in mols)

e) From the graph plotted, explain how concentration changes effects the rate of chemical reaction.

Solution

Table of results

Exp.No	Vol of A2(cm^3)	Vol of A1 (cm^3)	Vol of distilled water (cm^3)	Conc.Of A1 in (mols dm-3)	Time taken for the cross to dis (t) (sec)	1/t (sec-1)
1	50	30	20	0.12	37	$2.7x10^{-2}$
2	50	25	25	0.10	61	$1.6x10^{-2}$
3	50	20	30	0.08	96	$1.04x10^{-2}$
4	50	15	35	0.06	133	$7.5x10^{-3}$
5	50	10	40	0.04	242	$4.13x10^{-3}$

a. Concentration of A1:

Expt 1: 0.2 x 30

$= M_2 x50$

$M_2 = 0.12M$

Expt 2: 0.2 x 25

$= M_2 x50$

$M_2 = 0.10M$

Expt 3: 0.2 X 20

$= M_2 x\ 50$

$M_2 = 0.06M$

Expt 4: 0.2 x 15

$= \quad M_2\ x\ 50$

$M_2 = 0.06M$

Expt 5: 0.2 x 10

$= \quad M_2\ x\ 50$

$M_2 = 0.04M$

b. $Na_2S_2.O_{3_{(aq)}} + 2HCl_{(aq)} \rightarrow 2NaCl_{(aq)} + H_2O_{(l)} + SO_2 + S_{(s)}$

Net Ionic Equation

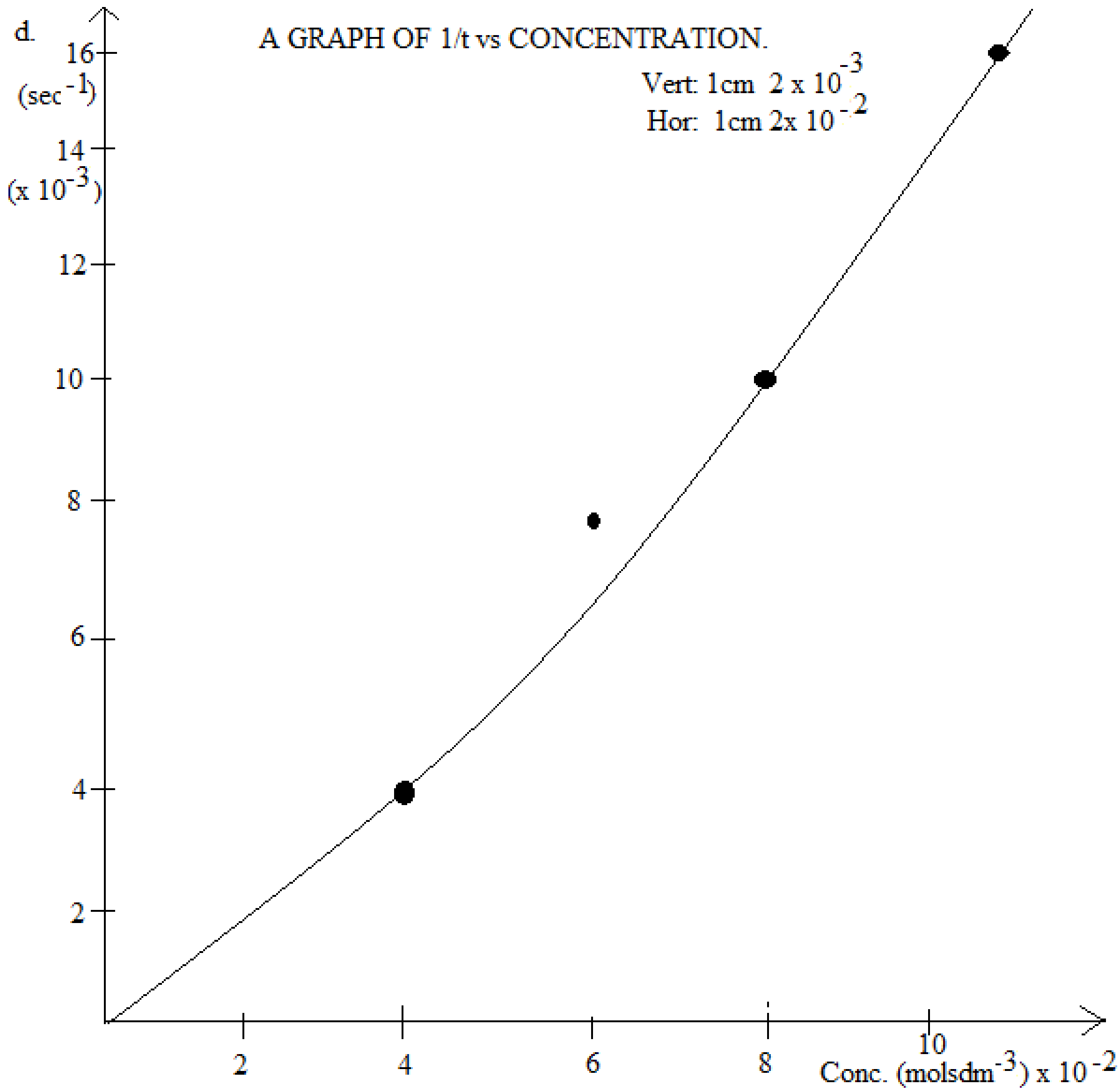
$2Na^+ + S_2O^{2-}{}_3 + 2H^+ + 2CL^- \rightarrow 2Na^+ + 2Cl^- + H_2O + 2 + s$

$S_2O^{2-}_{3(aq)} + 2H^+_{(aq)} \rightarrow H_2O + SO_{2_{(g)}} + S_{(s)}$

c) The smell experienced as the experiment proceeds is due to the formation (production) of Sulphur dioxide ($S0_2$) which has chocking irritating /metallic taste

The colour (creamy) seen is due to formation/precipitation of sulphur as the reaction proceeds.

d.



e. Increase in concentration of sodium thiosulphate increases the rate of the chemical reaction, and vice verse.

Practical 20

You are provided with the following:

P: Sodium thiosulphate solution (32.24g/dm^3)

Q: 2MHC1 solution

-Stopwatch, thermometer

Procedure

(i) Measure 50cm^3 of solution P into a 250cm^3 conical flask.

(ii) Place the flask on top of gauze on a tripod stand. Heat the flask with a gentle Bunsen burner flame.

(iii) Draw a cross on a piece of a white paper. Stir the solution in the conical flask until the temperature reaches 30°C.

(iv) Stand the flask on to paper above the cross and immediately add 5cm^3 of solution Q. At the same time start the stop clock. Stir the mixture with the thermometer.

(v) Observe the cross through the mouth of the flask as before. Stop the clock immediately as soon as the cross is obscured. Record the time. Read the temperature again and record this temperature in a table.

(vi) Repeat the experiment three more time with starting temperature of 40 °C, 50 °C and 60 °C each time use 5cm^3 of solution Q.

Table of results

Temperature(°C)	Time ,t, for the cross to disappear(s)	Rate of reaction i/t(s^{-1})
30		
40		
50		
60		
70		

Questions

a) Plot the graph of temperature(y-axis) against rate(x-axis)

b) Is the graph a straight line or a curve?

c) Did the time until the cross disappeared increase or decrease as the temperature was raised?

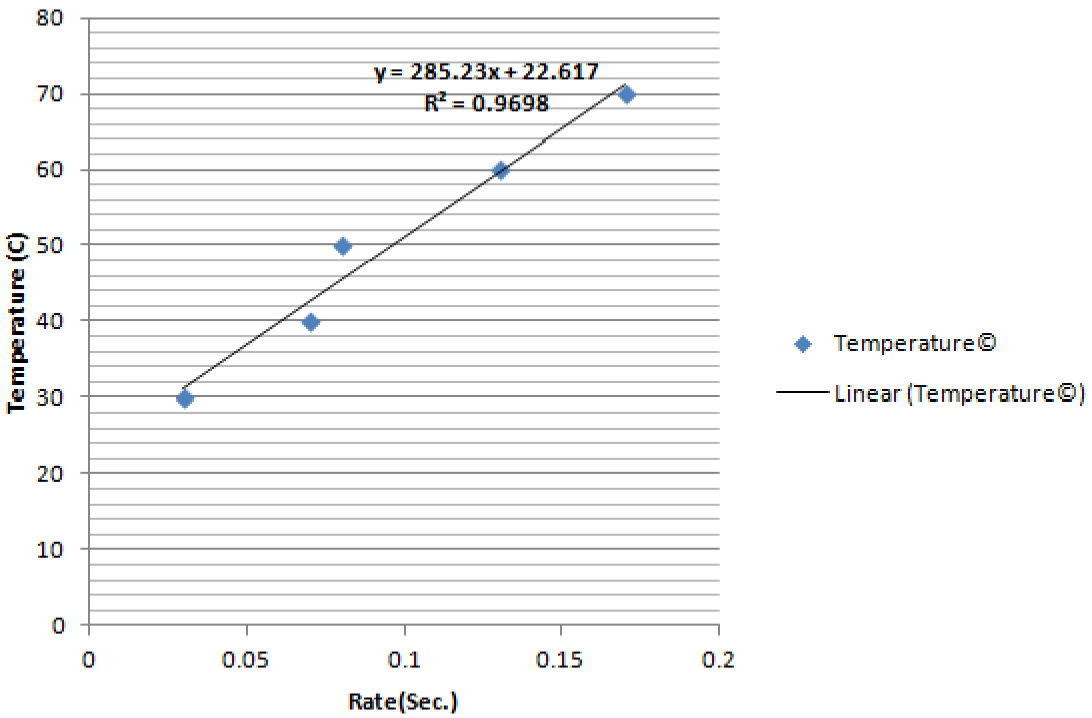
d) Did the rate or reaction until the cross disappeared increase or decrease as the temperature was raised?

Solution

Table of results

Temperature(°C)	Time ,t, for the cross to disappear(s)	Rate of reaction i/t(s^{-1})
30	**30**	**0.03**
40	**14**	**0.07**
50	**12**	**0.08**
60	**8**	**0.13**
70	**6**	**0.17**

a) **A graph of temperature against time**



b) The graph is straight line

c) As the temperature was raised the time for the cross to disappear decreases

d) Like ways as the temperature was raised the rate or reaction also increases.

Practical 21

You are provided with the following materials:

RR: A solution of 0.2M $Na_2S_2O_3$ (sodium thiosulphate)

GG: A solution of 0.1M HCl; Stopwatch; Distilled water.

Procedure:

a) Using 10cm measuring cylinder, measure 2cm of RR and 8cm3 of water and pour the content into the 100cm beaker.

b) Use different measuring cylinder to measure 10cm3 of GG and pour it into the beaker containing RR and distilled water and immediately start the stopwatch. Swirl the beaker twice.

c) Place the with the contents on top of a piece of paper marked X with blue pen or black pen.

d) Look down vertically through the mouth of the beaker so as to see the cross at the bottom of the beaker. Stop the clock when the letter x is invisible.

e) Record the time taken when the letter X disappear completely.

f) Repeat the experiment as shown in a table below

g) Record your results in a tabular form as shown below.

Exp.No	Volume of GG(cm^3)	Volume of RR(cm^3)	Volume of dist. Water(cm^3)	Time(s)	i/t(s^{-1})
1	10	2	8		
2	10	4	6		
3	10	6	4		
4	10	8	2		
5	10	10	0		

Questions

a) Complete filling the table of results (above table)

b) Write a balanced chemical equation for the reaction btn RR and GG

c) What is the product which causes the solution to cloud the letter X?

d) Plot a graph of i/t against the volume of thiosulphate.

e) Use the graph to explain how variation of concentration affects the rate of chemical reaction.

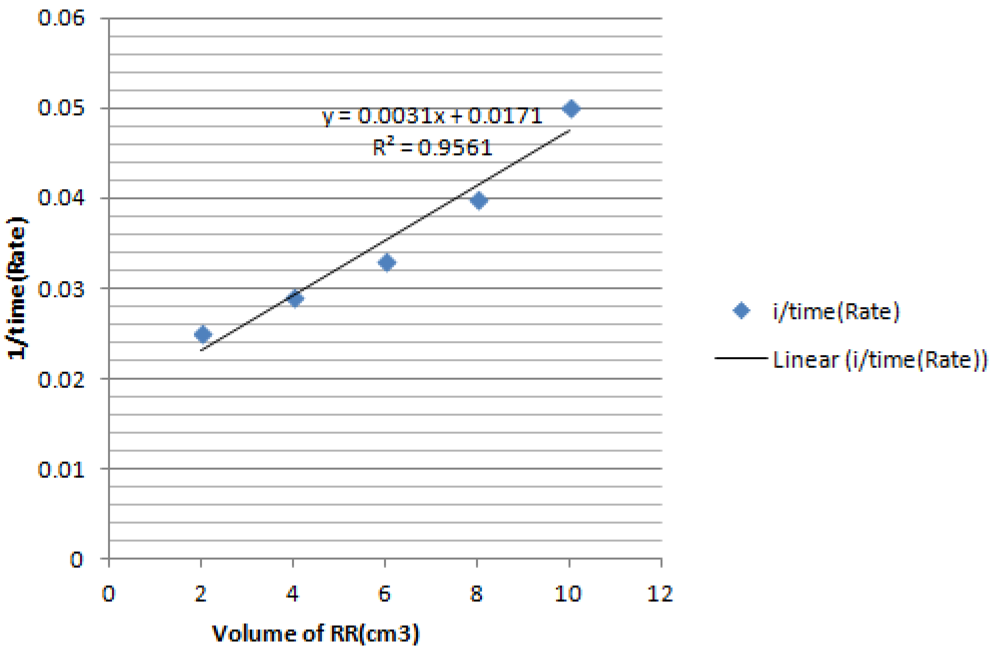
Solution

Exp.No	Volume of GG(cm^3)	Volume of RR(cm^3)	Volume of dist. Water(cm^3)	Time(s)	i/t(s^{-1})
1	10	2	8	40	0.025
2	10	4	6	35	0.029
3	10	6	4	30	0.033
4	10	8	2	25	0.040
5	10	10	0	20	0.050

b) Balanced chemical equation: $\mathbf{Na_2S_2O_3 + 2HCl \rightarrow 2NaCl + H_2O + S + SO_2}$

c) The product which causes the solution to cloud the letter X is **Sulphur**

d) **A graph of 1/time against Volume of sodium thiosulphate RR**



e) As concentration of the reactant(s) increases the rate of chemical reaction also increases

Practical 22

You are provided with the following solutions
M: 0.1M Solution of Sodium thiosulphate
N: IM HC1 solution
Carry out the following experiment and answer the questions.

Procedure:

i) Label six beakers as follows: P,Q, R, S, T, and U
ii) Pour 0.1M sodium thiosulphate solution to the six beakers so that 30cm^3, 25 cm^3, 20 cm^3, 15 cm^3, 10 cm^3, and 5 cm^3 portions go to the beakers respectively.
iii) Pour distilled water to the six beakers so that 0 cm^3, 5 cm^3, 10 cm^3, 15 cm^3, 20 cm^3 and 25 cm^3 portions go to the beakers respectively.
i) Draw a cross X on six white papers using a pen and place under each of the six beakers.
ii) Add 10 cm^3 of IM HCl solution into the beakers on the paper with X and at the same time start the stopwatch.
iii) Swirl well the mixtures and place the beaker over the cross
iv) Look through the mixture from above. Stop the stopwatch when the X immediately disappeared from the sight and record the times it takes for the cross X to disappear.
v) Repeat the procedure with the remaining five solutions.
vi) Record the results in a tabular form as shown below.

Experiment	Volume of $Na_2S_2O_3$ (cm^3)	Volume of H_2O (CM^3)	Volume of HCl (cm^3)	Time for the cross to disappear(s)
1	30	0	10	
2	25	5	10	
3	20	10	10	
4	15	15	10	
5	10	20	10	
6	5	25	10	

(i) Plot the graph of Volume of $Na_2S_2O_3$(y-axis) against time(x-axis)

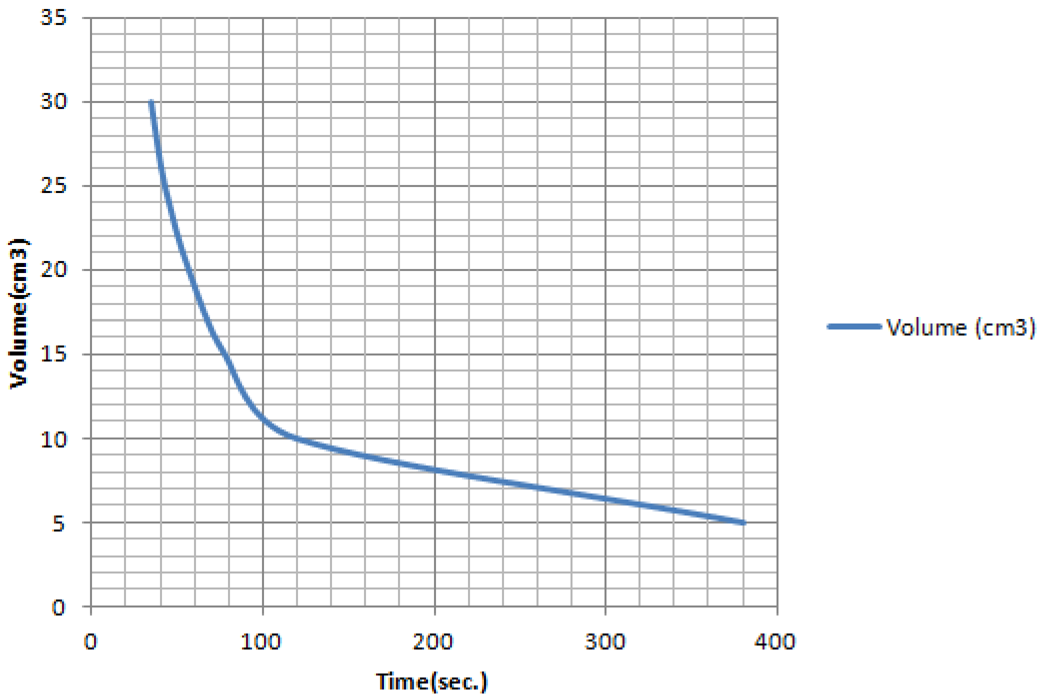
(ii) What does the shape for the graph indicate?
(iii) Write the chemical equation for the reaction btn $Na_2S_2O_3$ and HCl solution
(iv) Why did the cross disappear?

Solution

Table of results.

Experiment	Volume of $Na_2S_2O_3$ (cm^3)	Volume of H_2O (cm^3)	Volume of HC1 (cm^3)	Time for the cross to disappear(s)
1	30	0	10	35
2	25	5	10	43
3	20	10	10	57
4	15	15	10	78
5	10	20	10	120
6	5	25	10	380

(i) Graph of Volume of $Na_2S_2O_3$(y-axis) against time(x-axis)



(ii) The shape of the graph indicate that as the volume of sodium thiosulphate decreases the time taken for the cross to disappear increases

(iii) Balanced chemical equation; $\mathbf{Na_2S_2O_3 + 2HCl \rightarrow 2NaCl + H_2O + S + SO_2}$

(iv) The cross disappear due to **precipitation or formation of sulphur**

Practical 23

To determine the effect of concentration on the rate of reaction between $Na_2S_2CO_3$ and HC1

Materials: $Na_2S_2CO_3$ $5H_20$($32.24g/dm^3$), 2M HC1, Conical flask, two measuring cylinders, white piece of paper, black ink

Procedure:

(a) Mark a cross on piece of paper with black ink

(b) Measure $50cm^3$ of $Na_2S_20_3$ solution and pour it into a conical flask.

(c) Measure $10cm^3$ of HC1 solution using different measuring cylinder. Start a stopwatch as soon as you pour HC1 solution into a conical flask.

(d) Stand the conical flask on the paper above the cross. Look down vertically through the mouth of the conical flask and make sure you can see the cross at the bottom of the flask.

(e) Swirl the flask while keep on observing the cross until the cross disappears. Record the time in the table.

(f) Throw away the contents of the conical flask, and rinse it.

(g) Repeat the whole procedure using $40cm^3$, $30cm^3$,$20cm^3$ and finally $10cm^3$ of HC1 solution. In each experiment use $10cm^3$ of HC1 solution. Always record the time at which the cross disappears. Always to up $Na_2S_2CO_3$ with distilled water to make $50cm^3$ before adding the acid solution.

Table of results

Table of results

Volume of $Na_2S_2O_3(cm^3)$	Volume of distilled $H_2O(CM^3)$	Concentration of $Na_2S_2O_3$ after adding water$(moldm^{-3})$	Time,t, for the cross to disappear (s)	Rate of reaction, 1/t (s^{-1})
50	0	0.130		
40	10			
30	20			
20	30			
10	40			

a) Plot the graph of time (y-axis) against concentration of $Na_2S_2CO_3$ (x-axis)
b) Plot the graph of rate(y-axis) against concentration of $Na_2S_2CO_3$ (x-axis)
c) Which of the two graphs is:- i)a curve? ii) a straight line?
d) What conclusion can you draw from the results of this experiment

Solution

Table of results

Volume of $Na_2S_2O_3(cm^3)$	Volume of distilled $H_2O(CM^3)$	Concentration of $Na_2S_2O_3$ after adding water$(moldm^{-3})$	Time, t, for the cross to disappear (s)	Rate of reaction, 1/t (s^{-1})
50	0	0.130	20	0.05
40	10	0.104	24	0.04
30	20	0.078	34	0.03
20	30	0.052	50	0.02
10	40	0.026	110	0.01

Note: Concentration of $Na_2S_2O_3$ decreases after adding water as shown in the below dilution formula;

McVc =MdVd,

where **Mc** is Molarity of conc. Acid

Vc is Volume of conc. Acid

Md is Molarity of diluted acid and

Vd is final volume (volume of diluted acid)

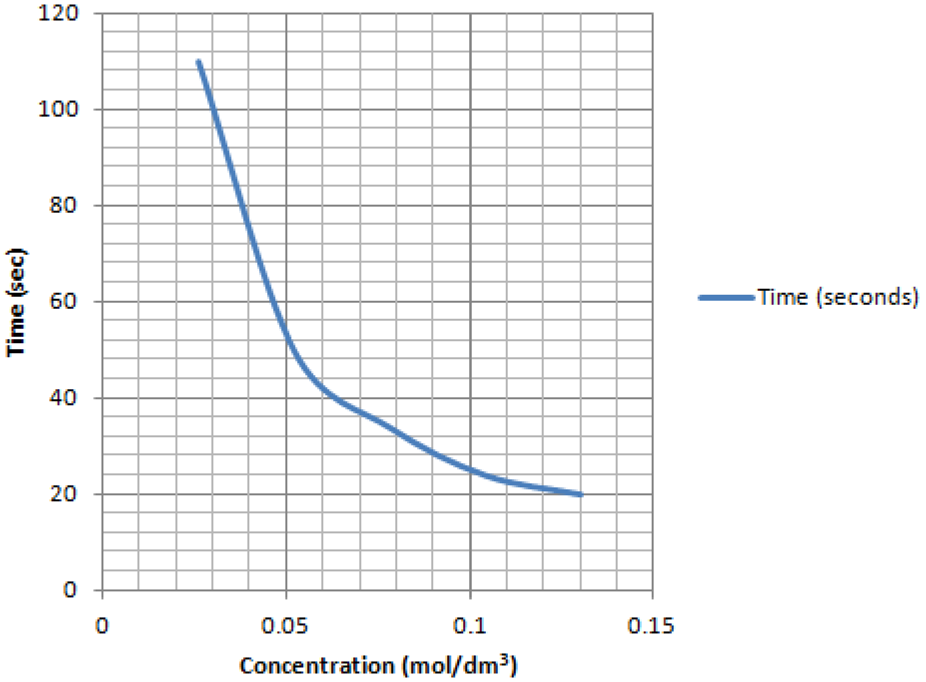
Then we have $Md = \frac{Mc \times Vc}{Vd}$, If Mc= 0.13M, Vc= 40cm^3, Vd= 50cm^3

$$= \frac{0.13 \times 40}{50}$$

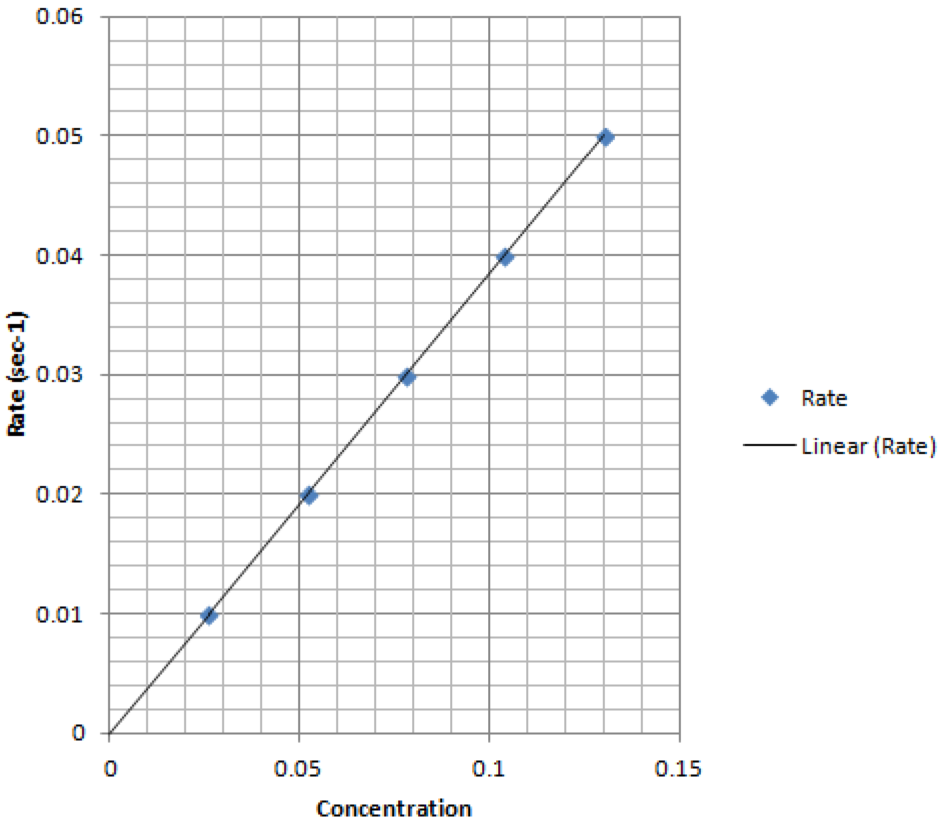
$= \mathbf{0.104Moldm^{-3}}$,

Therefore like ways you trill obtain other values of Concentration of Na2S:03 as you keep on adding water,

a) A graph of time (seconds) against concentration



b) A graph of rate against Concentration



c).i) Graph number (i) or (a) is a curve while graph number (ii) or (b) is a straight line starting from the origin.

d). Conclusion, as concentration of the solution or reactant decreases the time taken for the reaction to complete increases like ways as concentration increases the rate of chemical

Practical 24

You are provided with the following:

Solution **Z** *containing* 1 *M sodium thiosulphate* ($Na_2S_2O_3$);

Solution **T** *containing* 0.1 *M nitric acid* (HNO_3);

Distilled water;

Piece of water marked **X**;

Stop - watch.

Procedure

i) Using measuring cylinder, measure $5cm^3$ *of solution* **Z** *and put* 100 cm^3 *beaker.*

ii) Measure $5cm^3$ *of solution* **T** *and put into* 100 cm^3 beaker containing solution **Z**, and immediately start the stop – watch.

iii) Swirl the contents in the mixture from the above observe changes.

iv) Switch off the stop – watch when the mark X disappears.

v) Record the times taken for the letter X to disappear.

vi) Repeat procedures (i) to (v) using the data shown in Table 1.

Table 1.

Experiment	**Vol. of T (cm^3)**	**Vol. of Z (cm^3)**	**Vol. of Distilled water (cm^3)**	**Time (s)**
1	5	5	0	
2	5	4	1	
3	5	3	2	
4	5	2	3	

Question

a) Complete Table 1.

b) Write a balanced equation for reaction between **T** and **Z**

c) What substance was produced during the reaction which obscured letter X?

d) Plot the graph of volume of $Na_2S_2O_3$ solution against time (s).

e) What conclusion can you draw from this experiment?

Solution

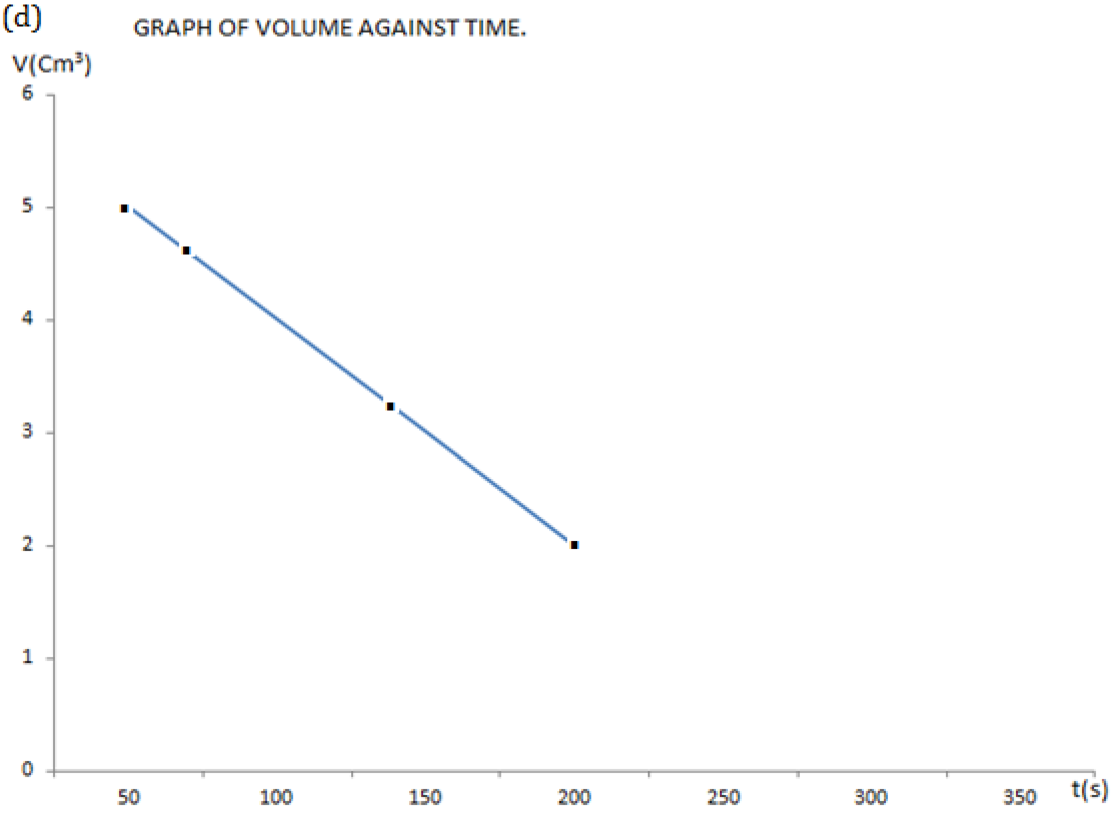
a) The completed Table 1

EXPERIMENT	**VOL. of T (cm^3)**	**VOL. of Z (cm^3)**	**VOL. of DISTILLED WATER (cm^3)**	**TIME (s)**
1	5	5	0	50
2	5	4	1	61
3	5	3	2	128
4	5	2	3	213

b) $Na_2S_2O_{3(aq)} + 2HNO_{3(aq)} \rightarrow 2NaNO_{3(aq)} + H_2O_{(l)} + SO_{2(g)} + S_{(s)}$

c) The letter X obscured by solid sulphur deposit.

(d)



e) From the graph a reaction depend on concentration of each reaction; where by decreasing of concentrate is the increasing of time of reaction.

Practical 25

The study of the rate of evolution of hydrogen from magnesium ribbon of uniform width with excess dilute hydrochloric acid was done in a certain school laboratory-. The results obtained were recorded as shown in the table below.

Length of magnesium ribbon in (cm)	1.0	2.0	3.0	4.0	5.0	6.0	7.0
Rate of evolution of hydrogen in (cm^3)/min	1.1	2.0	2.9	3.8	4.8	5.6	6.6

a) Write the equation of reaction between magnesium ribbons and dilute hydrochloric acid
b) Why was excess hydrochloric acid used in the experiment?
c) How did the rate of evolution of hydrogen gas vary with the length of magnesium ribbon?
d) What would be the effect on the rate of evolution of hydrogen if
i) The temperature was increased?
ii) Magnesium powder was used?
iii) A catalyst was used?
iv) A more diluted hydrochloric acid was used?

Solution

a) The equation for the reaction between magnesium ribbon and dilute hydrochloric acid.

$Mg_{(s)} + 2Hcl_{(aq)} \rightarrow MgCl_{2(aq)} + H_{2(g)}$

b) The excess hydrochloric acid was used in this experiment simply because one mole of magnesium ribbon requires two moles of hydrochloric acid to complete the reaction.

c) The rate of evolution of hydrogen gas (cm^3/ min) varies directly proportional with the length of magnesium ribbon, in other words we say, as the length of magnesium ribbon was increased the rate of evolution of hydrogen gas was also increased.

d) **(i)** If the temperature was increased the rate of evolution of hydrogen gas would also increases. At higher temperatures reactant particles move faster and collide more often and more violently.

ii) If magnesium powder was used instead of magnesium ribbon the reaction becomes faster and hence increases the rate of evolution of hydrogen.

iii) If the catalyst was used, the rate of chemical reaction normally increases, likewise as the catalyst was used the rate of evolution of hydrogen also increases.

iv) If more dilute hydrochloric acid was used in this experiment, the reaction will stop because the excess hydrochloric acid will be left over, unable to react as there are no more magnesium ribbon and hence the rater of evolution of hydrogen gas will be zero. i.e. will stop evolving.

(C) Qualitative analysis

Practical 26

Sample S is a simple salt containing one cation and one anion. Carry out the experiments describe below. Record your observations and inferences as shown in table 2.

Table 2: Experiments results

Table 2: Experiments results

S/n	Experiment	Observation	Inference
a) **b)**	Observe the appearance of sample S Place a spoonful of Sample S in a test tube. Add water and shake to dissolve.		
c)	Put a spatulaful of Sample S in a test tube and heat		
d)	Add three drops of sodium hydroxide solution to the solid sample in a test		
e)	Put a spatulaful of sample S in a dry test tube and add concentrated sulphuric acid. Warm the mixture and test for any gas evolved.		
f)	Put a spatulaful of sample S in a dry test tube and add concentrated sulphuric acid and manganese dioxide. Warm the mixture and test for any gas evolved.		
g)	To a portion of the solution from (f) add aqueous silver nitrate followed by aqueous ammonia.		

Conclusion

a) The cation present in S is…………and the anion is……………..

b) The name of sample S is…………………….

c) Write a balanced chemical equation for the reactions taking place in experiments (c) and (d)

Solution

Table 2: Experiment results:

S/a	Experiment	Observation	Inference
a)	Observe the appearance of sample S	-White crystalline substance was observed	Absence of transition elements (e.g.Fe^{2+}, Fe^{3+}, Cu^{2+}, etc)
b)	Spoonful of Sample S was placed in a test tube, followed by water and mixture was then shaken	-Sample completely dissolved in water (soluble in water)	-Insoluble salts was absent
c)	A spatulaful of Sample S in a test tube and heated	-White sublimate was formed on the cooler port of the test tube and ammonia gas was defected.	NH_4^+ may present or NH_4^+
d)	Three drops of sodium hydroxide solution to the solid sample in a test tube was added.	|- Smell of ammonia -Ammonia gas evolved that turns litmus paper from red to blue	NH_4^+ present confirmed
e)	A spatulaful of sample S in a dry test tube, followed by addition concentrated sulphuric warmed and the gas was	-Colourless gas which gives white fumes with ammonia (HCL gas was evolved)	Cl^- was present
f)	A spatulaful of sample S was put in a dry test tube, followed by addition of concentrated sulphuric acid and manganese dioxide. Mixture was then warmed and gas evolved	-Greenish yellow gas with pungent small was given out (Cl_2) which turns moist KI starch paper blue.	Cl^- was present confirmed
g)	To a portion of the solution from (f) aqueous silver nitrate solution was added followed by aqueous ammonia.	- White precipated (ppt)was formed but soluble in ammonia solution	Cl^- was present confirmed

Conclusion

a) The cation present in S was NH_4^+ the anion Cl^-

b) The name of sample S was Ammonium chloride

c) - Balanced chemical equation for the reaction taking place in experiment

$$NH_4Cl_{(s)} \rightleftharpoons HCl_{(g)} + NH_{3(g)}$$

- balanced chemical equation for the reaction taking place in experiment (d).

$$NH_4Cl_{(s)} + NaOH_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)} + NH_{3(g)}$$

Practical 27

Sample **Q** is a simple salt containing one cation and one anion. Carry out the experiments described below. Record carefully your observations, inferences and finally identify the anion and cation present in sample **Q**.

S/n	Experiment	Observation	Inference
(a)	Observe the appearance of sample **Q**.		
(b)	Dissolve a little sample **Q** in distilled water in a test tube, stir and then boil.		
(c)	Put a spatulaful of sample **Q** in a test tube then add concentrated sulphuric acid and warm.		
(d)	Put a spatulaful of sample **Q** in a test tube and then add dilute nitric acid. Divide the resulting solution into three portions and add the following: i. NaOH solution till in excess to the first portion.		
	ii. KI solution till in excess to the second portion.		
	$AgNO_3$ solution followed by dilute HNO_3 and then NH_3 solution to the third portion.		

Conclusion

i) The cation in sample Q is ....

ii) The anion in sample Q is ....

iii) The formula of the compound Q is ....

iv) The name of compound Q is ....

Solution

S/n	Experiment	Observation	Inference
(a)	Observe the appearance of sample **Q**.	White crystal salt	Absence of transitional metals
(b)	Dissolve a little sample **Q** in distilled water in a test tube, stir and then boil.	The sample is soluble in water	CL^{-},NO_3, $SO4^{2-}$ may be present
(c)	Put a spatulaful of sample **Q** in a test tube then add concentrated sulphuric acid and warm.	Colorless gas evolved out which give white fumes with Ammonia mean that Ha gas evolved	CL^{-}, may present
(d)	Put a spatulaful of sample **Q** in a test tube and then add dilute nitric acid. Divide the resulting solution into three portions and add the following: i. NaOH solution till in excess to the first portion.	White ppt insoluble in excess Ammonia, then disappear whin NaOH is added	Pb^{2+} may present
	ii. KI solution till in excess to the second portion.	Yellow ppt is formed and disappear when heating	Pb^{2+} is confirmed
	$\mathrm{Ag}NO_3$ solution followed by dilute HNO_3 and then NH_3 solution to the third portion.	White ppt insoluble in HNO_3	CL^{-}, confirmed

Conclusion

i) The cation is Pb^{2+}

ii) The anion is CL^{-}

iii) The formural $Pbcl_2$

iv) Lead chloride

Practical 28

Sample B is a simple salt containing one cation and one anion. Carry out carefully the experiments described below and record all your observations and appropriate inferences. Identify the cation and anion present in sample

Experiment	Observation	Inference
(a) Appearance of sample B		
(b) To half a spatulaful of sample B in a test tube, add concentrated sulphuric acid and warm.		
(c) To a spatulaful of sample B in a test tube, and 10cm^3 of distilled water and stir to obtain a stock solution then divide it into three portions.		

(d) The first portion of the stock solution, add sodium hydroxide till excess.		
(e) To the second portion of the stock solution, add barium chloride solution.		
(f) To the third portion of the stock solution, add freshly prepared acidified ferrous sulphate solution followed by concentrated sulphuric acid added slowly along the walls of the test tube.		
(g) Perform a flame test on sample B.		

Conclusion

The cation in sample B is ....and the anion is ....

Solution

Experiment	Observation	Inference
(a) Appearance of sample B	Blue crystals was observed	Cu^{2+} was suspected
(b) To half a spatulaful of sample B in a test tube conc. sulphuric acid was added and warmed.	Brown fumes which intensifies on addition of copper turnings (No_2 was evolved)	NO_3^- was suspected
(c) To a spatulaful of sample B in a test tube, $10cm^3$ of distilled water was added and stirred to obtain a stock solution, then the stock solution was divided into three portions.	Soluble in distilled water, forming blue solution	Insoluble salt was absent.

(d) To the first portion of the stock solution, sodium hydroxide solution was added till excess.	Blue precipitate (ppt) Insoluble in excess was observed. Ppt turns black on heating	Cu^{2+} was suspected
(e) To the second portion of the stock solution, barium chloride solution was added.	No precipitate was formed	SO_4^{2-} was absent
(f) To the third portion of the stock solution, freshly prepared acidified ferrous sulphate solution was added followed by concentrated sulphuric acid added slowly along the walls of the test tube.	Brown ring was formed	NO_3^- Present confirmed.
(g) A flame test was performed	Blue/green or dark green flame was observed.	Cu^{2+} was suspected

Practical 29

Sample N is a simple salt containing one cation and one anion. Using systematic qualitative analysis procedures carry out tests on the sample and make appropriate observations and inferences to identify the cation and anion in simple.

Experiment	**Observation**	**Inference**
(a) Appearance of sample N		
(b) A spatulaful of a solid sample N was put in a dry test tube and heated strongly, gas evolved were		
(c) Action of dil. Acid (s) on a solid sample (N)		
(d)To a sample solid N in a test tube, conc, sulphuric acid was added.		
(e)To a sample solution N, sodium hydroxide solution was added till in excess		
(f)Toa sample solution N in a test tube, aqueous ammonia was added until in		

(g)To a sample solutionN potassium ferrocyanide solution till in excess		
(h) To a sample solution (N) silver nitrate ($AgN0_3$) solution was added followed by dil. $HN0_3$ solution then excess ammonia solution.		

Conclusion

The cation present in N …………………. And the anion is …………………

Solution

Data from the laboratory

Experiment	Observation	Inference
(a) Appearance of sample N	While crystalline substance was observed	Transition elements was absent (Fe^{2+},Fe^{3+},Cu^{2+})
(b) A spatulaful of a solid sample N was put in a dry test tube and heated strongly, gas evolved were tested.	Yellow residue was formed when hot and white when cold Colourless liquid forming droplet on the cooler part of a test tube.	Zn^{2+} was suspected Hydrated salt was suspected.
(c) Action of dil. Acid (s) on a solid sample (N)	No effervescence was observed but sample dissolved completely in mineral acids	CO_3^{2+}or$HC0_3^-$ was absent
(d)To a sample solid N in a test tube, cone, sulphuric acid was added.	Colourless gas that give white fumes with ammonia was observed (HC1 gas was	Cl^- was suspected
(e) To a sample solution N, sodium hydroxide solution was added till in excess	A white precipitate (ppt) which is soluble in excess was observed.	Pb^{2+},Zn^{2+} Was suspected.
(f)Toa sample solution N in a test tube, aqueous ammonia was added until in excess	White gelatinous precipitate (ppt) was formed soluble in	Zn^{2+} was suspected
(g)To a sample solution N potassium ferrocyanide solution till in excess	Bluish white ppt was formed insoluble in excess potassium ferrocyanide	Zn^{2+} present, confirmed
(h) To a sample solution (N) silver nitrate ($AgN0_3$) solution was added followed by dil. $HN0_3$ solution then excess ammonia solution.	White precipitate (ppt) insoluble in dil. $HN0_3$ but soluble in ammonia solution.	Cl^- was present, confirmed

Conclusion

The cation present in N was Zn^{2+} and anion was Cl^-

Practical 30

Sample X contains one cation and one anion. Carry out guide experiment to described below carefully and record the observation made and inferences. Identify the cation and anion in the salt X.

Experiment	Observation	Inference
a Appearance of sample X b Put about a spatula full of x in a dry test tube and heat. c To a little amount of X in a test tube add conc. H_2SO_4. Warm gently followed by the addition of small pieces of copper metal. d Carry out flame test of sample x. e To a sample solution X add NaOH solution drop wise till excess. f To a sample solution X add ammoa solution drop wise till excess.		
g To a sample solution X add freshly prepared ferrous sulphate followed by conc. H_2SO_4 along the sides of the test tube while at slanted position. h To a sample solution X add potassium ferrocyanide solution		

i) The cation in the sample X is………………

ii) The anion in the sample X is …………………

iii) The formula of sample X is…………………..

iv) Write the chemical equation for reaction which took place in experiment b.

Solution

Experiment	Observation	Inference
a) Appearance of sample X	Blue deliquescent crystals were observed.	Cu^{2+} may be present
b) About a spatulaful of x was put in a dry test tube and heated.	Reddish brown gas evolved and the residue formed was black.	Na_3^- may be present Cu^{2+} may be present
c) To a little amount of X in a test tube add conc. H_2SO_4. Was added and Warmed gently followed by the addition of small pieces of copper metal.	Reddish brown gas was evolved; the gas turned dark brown on addition of copper turnings.	NO_3^- was suspected
d) Flame test of sample x.	Bluish green flame was observed	Cu^{2+} was present
e) To a sample solution X NaOH solution was added drop wise till excess.	Blue precipitate (ppt) was formed.	Cu^{2+} was suspected
f) To a sample solution X in test tube, ammonia solution was added drop wise till excess.	Blue ppt which turns into deep blue solution in excess ammonia.	Cu^{2+} may be present

g) To a sample solution X in test tube, freshly prepared ferrous sulphate solution was added followed by addition of conc. H_2SO_4 along the sides of the test tube while at slanted position.	Brown ring was formed and observed	NO_3^- was present and confirmed
h) To a sample solution X add potassium ferrocyanide solution	Reddish brown gelatinous ppt was a formed, soluble in aqueous ammonia but insoluble in mineral acids.	Cu^{2+} was present and confirmed.

i) The cation in the sample X was Cu^{2+}

ii) The anion in the sample X was Na_3^-

iii) The formulary of sample X was $Cu(No_3)_2$

iv) The chemical equation took place in experiment b:

$$2Cu(NO_3)_{2(s)} \xrightarrow{\Delta} 2CuO_{(s)} + 4NO_{2(g)} + O_{2(g)}$$

Practical 31

Sample M is a simple sail containing one cation and one anion. Carry out carefully the experiments described in the following table. Research all your observations and appropriate inferences to identify the ions present in M.

S/N	Experiment	Observation	Inference
a.	Appearances of sample M		
b.	Place a spatulaful of sample M in a test-tube and heat		
c.	Place a spatulaful of sample M in a test tube and add hydrochloric acid. Test for any gas (es) evolved. Add more of the acid until the test tube s half full. Divide the solution into three portions and then do the following; i) Add sodium hydroxide solution drop wise and then in excess to the first portion.		

	ii) Add a few drops of potassium iodide solution to the second portion.		
	iii) Add ammonium hydroxide solution drop wise till excess to the third portion.		

Conclusion

The cation in sample M is ……………..and the anion is…………………………

Solution

S/N	Experiment	Observation	Inference
	Appearances of sample M	White powder substance was observed	- Absence of transition elements (eg. Fe^{2+}, Fe^{3+}, Cu^{2+})
	Place a spatulaful of sample M in a test-tube and heat	- Colorless gas which turns lime water – milky (Co_2 das evolved) was observed - Residue reddish brown when hot, yellow when cold.	• $Co^{2-}{}_3$ was present • Pb^{2+} may be present
	Place a spatulaful of sample M in a test tube and add hydrochloric acid. Test for any gas (es) evolved. Add more of the acid until the test tube s half full. Divide the solution into three portions and then do the following; i. Add sodium hydroxide solution drop wise and then in excess to the first portion.	Effervescence was observed and gas evolved turned lime water milky (Co_2 das evolved) Sample M dissolved completely in excess acid White precipate (ppt) soluble in excess was observed.	• $HCO^-{}_3$ or • $CO^{2-}{}_3$ was present • Pb^{2+} or Zn^{2+} present
	ii. Add a few drops of potassium iodide solution to the second portion.	Yellow precipitate (ppt) was formed, soluble on heating, but reappears on cooling.	• Pb^{2+} Present, confirmed.

	iii. Add ammonium hydroxide solution drop wise till excess to the third portion.	White precipitate (ppt) soluble in excess	• Ca^{2+}, Pb^{2+} Present.

Conclusion

The cation in sample M was Pb^{2+} and anion was $C0_3^{2-}$

Practical 32

Substance V is a simple salt containing one cation and one anion. Using systematic qualitative analysis procedures carry one tests on V and make appropriate observations and inferences to identify cation in V. record your experiments, observations and inferences as shown in the following table:

Experiment	Observation	Inference

Conclusion

The cation in sample V is……………..and the anion is.

Solution

Experiment	Observation	Inference
(a) Appearance of sample V	- Blue / green crystals was observed	Cu^{2+} present
(b) Action of heat on solid sample V	- colored liquid forming droplets on the cooler part of the test tube - brown gas which turns litmus paper from blue to red (No_2 das evolved). - Blue salt that turns black and remain as black residue on heating.	• Hydrated salt of Cu^{2+} present • No^{-}_3 present • Cu^{2+} present
(c) Action of dil.acid HCl on sample V	- No effervescence occurred.	• NO^{-}_3 present
(d) Action of conc. sulphuric acid on solid sample V	• Brown fumes that intensifies an addition of copper turning (No_2 das evolved)	• No Co^{2-}_3 or HCo^{-}_3 (Absent)

(e) Action of sodium hydroxide solution on a solution of V in a test tube.	• Blue precipitate (ppt) insoluble in excess was formed. The ppt turns black on heating	Cu^{2+} was present
(f) Action of aqueous ammonia on a solution of sample V in a test tube	• Pale blue precipitate (ppt) soluble in excess forming a deep blue solution	Cu^{2+} present
(g) Solubility of sample V .in distilled water	• Sample was soluble in distilled water forming blue solution	Soluble salts of Cu^{2+} present
(h) Potassium ferrocyanide solution was added to a solution of V	• Reddish Brown gelatinous ppt was formed soluble aqueous ammonia but insoluble in aqueous mineral acids	Cu^{2+} present confirmed
(i) Flame test; A glass was dipped in conc. Hcl and touched with solid sample V and burnt on a Bunsen burner flame.	• Blue / green flame was observed	Cu^{2+} present
(j) A freshly prepared ferrous Sulphate solution was added to a solution of V followed of Conc. H_2SO_4 along the side of the test tube	• Brown ring was formed	$NO^-{}_3$ Present confirmed.

Conclusion

The cation in sample V was Cu^{2+} and the anion was No_3^-

Practical 33

Substance W is a simple salt which contains one cation and one anion. Carry out the experiments described below. Records carefully your observations and make appropriate inferences and hence identify the anion and cation present in sample W.

S/n	Experiment	Observation	Inference
1	Observe the appearance of sample W		
2	Put a very little amount of W in a test tube then add water to about half-full test tube, if it did not dissolve heat or warm it. Divide the resulting solution into three portions.		
	a)To the 1st part, add potassium chromate solution		

	b)To the 2^{nd} part add potassium iodide solution		
	c)To the 3^{rd} part, add AgNo3 solution followed by dil.HNO3 then excess ammonia solution		
3	Heat a little amount of W in a dry test tube		
4	To little solid sample W, add conc.H_2SO_4 acid drop wise then heat/warm the mixture		

Conclusion

I. The cation in sample W is ____________

II. The anion in sample W is ____________

III The chemical formula of W is ____________

IV The name of compound W is ____________

Solution

S/n	Experiment	Observation	Inference
1	Observe the appearance of sample W	-White powder	-Absence of transition elements.eg(Cu^{2+}, Fe^{2+}, Fe^{3+})
2	Put a very little amount of W in a test tube then add water to about half-full test tube, if it did not dissolve heat or warm it. Divide the resulting solution into three portions.	-Sparingly soluble in cold water but soluble in hot water	-Either $PbCl_2$, $CaSO_4$,or $Ca(OH)_2$ may be present
	a)To the 1^{st} part, add potassium chromate solution	Yellow ppt formed soluble in sodium hydroxide but insoluble in ammonia solution	Pb^{2+} present, confirmed
	b)To the 2^{nd} part add potassium iodide solution	Yellow ppt formed soluble in potassium iodide or on heating but reappears on cooling	Pb^{2+} present, confirmed
	c)To the 3^{rd} part, add $AgNo_3$ solution followed by dil.HNO_3 then excess ammonia solution	White ppt insoluble in dil. HNO_3 but soluble in ammonia solution	Cl^- present, confirmed
3	Heat a little amount of W in a dry test tube		
4	To little solid sample W, add conc.H_2SO_4 acid drop wise then heat/warm the mixture	Greenish –yellow gas with pungent smell (Cl_2) is given out which turns moist KI-starch paper blue	Cl^- present, confirmed

Conclusion
I. The cation in sample W is Pb^{2+}
II. The anion in sample W is Cl^-
III. The chemical formula of W is $PbCl_2$
IV. The name of compound W is **Lead II chloride**

Practical 34

Sample D is a simple salt containing one cation and one anion. Carry out carefully the experiments described below recording all your observations and appropriate inferences as shown in Table 2 to identify the cation and anion present in D.

Experiment		Observation	Inference
a.	Observe the appearance of salt D.		
b.	Put a little solid sample D in a clean and dry test tube and heat		
c.	Put a spatulaful of sample D in a test tube and add distilled water. Stir and divide the obtained solution into four portions in different test tubes. To the i) First portion of the solution of sample D in a state tube add aqueous ammonia slowly till excess.		
	ii) Second portion of the solution of sample D in a test tube add suppose to be NaOH slowly till excess		
	iii) Third portion of the solution of sample D in a test tube add potassium hexaeyanoferrate (H)		
	iv) Fourth portion of the solution of sample D in a test tube add dilute HCl followed by $BaCl_2$ solution		

Conclusion
The cation in sample D is…………..and the anion is……………………
The molecular formula of salt D is……………………….

Solution

S/N	Experiment	Observation	Inference
	A ppearance of salt D	- Blue crystals was observed	Cu^{2+} was present
	A little sample D was put in a clean and dry test tube and heated	- Colored liquid forming droplets on the cooler part of the test tube liquid turned anhydrous $CuSO_4$ blue . - Blue solid turned white when conc. H_2SO_4 was added even without heating. - Blue salt turned black and remain as black residue even after cooling.	• Hydrated salt was suspected • Hydrated copper salt was suspected • Cu^{2+} was suspected
	A spatulaful of sample D in a test tube and add distilled water. Stir and divide the obtained solution into four portions in different test tubes:- To the	Sample D dissolved completely id distilled water forming blue solution.	• Soluble salts of Cu^{2+} was suspected.
	i. First portion of the solution of sample D in a state tube add aqueous ammonia slowly till excess.	- Pale blue precipitate (ppt) soluble in excess forming a deep blue solution	• Cu^{2+} was suspected.
	ii. To the Second portion of the solution of sample D in a test tube aqueous sodium hydroxide was added slowly till excess	White precipitate (ppt) soluble in excess	• Cu^{2+} was Suspected.
	iii. Third portion of the solution of sample D in a test tube potassium hexacyanoferrate (II) was added	- Reddish brown gelatinous precipitate was formed soluble in aqueous ammonia but insoluble in aqueous mineral acids	• Cu^{2+} was confirmed.

	iv. Fourth portion of the solution of sample D in a test tube add dilute HCl was added followed by addition of $BaCl_2$ solution	- While precipitate (ppt) insoluble in dil. HCl was formed	• SO^{2-}_4 Present, confirmed.

Conclusion

The cation in sample D was Cu^{2+} and anion was SO^{2-}_4

The Molecular formula of salt D was $CuSO_4$

Practical 35

Substance Y is a simple salt containing one anion and one cation. Using systematic qualitative analysis procedures carry out tests on Y and make appropriate observations and inferences to identify cation in and anion present in sample Y.

Experiment	Observation	Inference

Conclusion

The cation in sample Y is…………………and the anion is……………………

Solution

Experiment	Observation	Inference
(a) Appearance of sample Y	- White crystalline crystals was observed	transition elements (Fe^{2+}, Fe^{3+}, absent
(b) A little solid sample Y was put in a clean and dry test tube and heated	- colored liquid forming droplets on the cooler part of the test tube was observed	• Hydrated salt was suspected
(c) A glass rod was dipped in conc. HCl and then it was touched with a solid sample Y and then it was burnt on Bunsen burner flame.	- Brick red color was observed.	• Ca^{2+} was suspected
(d) A spatulaful of sample Y was put in a test tube and then, distilled water was added and stirred properly.	• Sample Y was soluble in distilled water farming clear solution	• Absence of insoluble salts.

(e) Action of aqueous ammonia on a solution of sample Y in a test tube.	• White precipitate (ppt) was observed but soluble in excess	• Ca^{2+}, Pb^{2+} was suspected
(f) Action of sodium hydroxide solution on a solution of sample Y in a test tube	• White precipitate (ppt) insoluble in excess NaOH was formed	• Ca^{2+} was suspected
(g) A little solid sample Y was put in a dry test tube followed by addition of Conc. H_2SO_4.	• Colorless gas which gives white dense fume with ammonia was observed (HCl gas was evolved).	• Cl^- Was suspected.
(h) To a sample solution Y, ammonium oxalate solution was added	• White ppt insoluble in acetic acid but soluble in mineral acid was observed	Ca^{2+} present confirmed
(i) To a sample solution Y $AgNo_3$ solution was added, followed by dil. HNO_3 solution then in excess ammonia solution	• White ppt insoluble in dil. HNO_3 but soluble in ammonia solution	Cl^- present, confirmed

Practical 36

Use the information given under the experiment and inference columns in table 2 below to complete the observation column.

Experiment	Observation	Inferences.
(a) Appearance of sable **Z**		Probably Fe^2 or Cu^2 present.
(b) To a portion of solid **Z** in a test tube. Concentrated sulphiric acid was added and the gas given off was tested.		Cl present
c) To another portion of **Z** in a test tube. MnO_2 was added followed by concentrated H_2SO_3. The gas evolved was passed over moist litmus paper		Cl confirmed
(d) Sample **Z** was dissolved in distilled water.		Soluble salts of Cu^2 suspected

(e) Excess sodium hydroxide solution was added to the solution of sample **Z** and heated.		Residue is CuO thus Cu^2 is present.
(f) Ammonium hydroxide solution was added to a solution of Z until excess.		Cu^2 confirmed.

Table 2

Conclusion

The cation is sample Z is _______ and the anion is ___________

Solution

Experiment	Observation	Inferences.
(a) Appearance of sable **Z**	Blue or green crystals	Probably Fe^2 or Cu^2 present.
(b) To a portion of solid **Z** in a test tube. Concentrated sulphiric acid was added and the gas given off was tested.	Colorless gas which gives white fumes with ammonia (Hcl gas) evolved	Cl^- present
c) To another portion of **Z** in a test tube. MnO_2 was added followed by concentrated H_2SO_3. The gas evolved was passed over moist litmus paper	Greenish – yellow gas with pungent smell (Cl_2) is given out which turns KI starch paper blue.	Cl^- confirmed
(d) Sample **Z** was dissolved in distilled water.	• Blue/green solution was formed. • Soluble in water.	Soluble salts of Cu^2 suspected
(e) Excess sodium hydroxide solution was added to the solution of sample **Z** and heated.	• Blue PPT insoluble in excess. The precipitate (PPT) turns black on heading.	Residue is CuO thus Cu^2 is present.
(f) Ammonium hydroxide solution was added to a solution of Z until excess.	Pale blue PPT soluble in access forming a deep blue solution.	Cu^{2+} confirmed.

Conclusion

The cation in sample Z is Cu^{2+} and the anion is Cl^-

Practical 37

Sample X is a Salt containing one cation and one anion. Carry out carefully all experiments listed below. Record all your observations and make appropriate inferences to identify the ions in sample X.

S/N	Experiments	Observations	Inferences
	Appearance of sample X		
	Place a spatula full of X in a dry test tube addconc. Sulphuric acid and warm gently with copper turnings or small pieces of copper		
	To a solution of X add ammonia solution drop wise till no further change.		
	To another solution of X add potassium fetrocyanide solution		
	To another solution of X add freshly prepared iron (II) sulphate solution followed by concentrated sulphuric acid down the side of testtube.		
	To a solution of X add potassium thiocyanite solution		

Conclusion:

The cation in sample X is……………………….

The anion in sample X is……………………….

The compound is ……………………………..

Solution

S/N	Experiments	Observations	Inferences
	Appearance of sample X	Yellow/ golden yellow	Fe^{3+} may be present
	Place a spatula full of X in a dry test tube add conc. Sulphuric acid and warm gently with copper turnings or small pieces of copper	Brown fumes which intensified on addition of copper turning- NO_2 gas is evolved	NO_3^- may be present
	To a solution of X add ammonia solution drop wise till no further change.	Reddish brown ppt insoluble in excess is formed	Fe^{3+} may be present
	To another solution of X add potassium ferrocyanide solution	Blue ppt formed	Fe^{3+} present, confirmed
	To another solution of X add freshly prepared iron (II) sulphate solution followed by concentrated sulphuric acid down the side of test tube.	Brown ring is formed	NO_3^- present, confirmed
	To a solution of X add potassium thiocyanite solution	Deep red solution is observed	Fe^{3+} present, confirmed

Conclusion:

The cation in sample X is Fe^{3+}

The anion in sample X is NO_3^-

The compound is $Fe(NO_3)_3$

Practical 38

Substance H is a simple salt which contains one cation and one anion. Carry out the experiments described below. Record your observations and make appropriate inferences and hence identify the cation and anion present in sample H.

S/n	Experiments	Observation	Inferences
a	Observe the appearance of sample H		
b	Put a spatula-full of sample H in attest tub, then heat until no further change occurs		
c	To a little sample H in attest tube add dilute hydrochloric acid		
d	To a little solid of sample H add few drops of cone. H_2SO_4		
e	Flame test on sample H		
f	Dissolve sample H in distilled water. Divide the resulting solution into four portions and then add the following		
	i. To the first portion add NaOH solution drop wise then in excess		
	ii. To the second portion add NH4OH solution drop wise then in excess		
	iii. To the third portion add Barium Chloride solution followed by dilute hydrochloric acid.		
	iv. To the forth portion add potassium ferrocyanide.		

Conclusion:
The Cation present in sample H is………………………..
The Anion present in sample H is………………………….
Compound H is ………………………………….

Solution

S/n	Experiments	Observation	Inferences
a	Observe the appearance of sample H	Blue crystals	Transition elements(CU^{2+}, Fe^{2+}) may be present
b	Put a spatula-full of sample H in attest tub, then heat until no further change occurs	Blue solid turns white and water droplets were observed at the cooler part of the test tube	Hydrated CU^{2+} may be present
c	To a little sample H in attest tube add dilute hydrochloric acid	No effervescence observed, No ppt observed	Absence of HCO_3^- or CO_3^{2-}
d	To a little solid of sample H add few drops of conc. H_2SO_4	Blue solid turns white	Hydrated CU^{2+} may be present
e	Flame test on sample H	Blue-green flame was observed	CU^{2+} may be present

f	Dissolve sample H in distilled water. Divide the resulting solution into four portions and then add the following	The salt dissolved completely in water forming blue solution	Insoluble salts absent
	i. To the first portion add	Blue ppt was formed	CU^{2+} may be
	NaOH solution drop wise then in excess	insoluble in excess of NaOH solution.	present
	ii. To the second portion add NH_4OH solution drop wise then in excess	Pale blue ppt soluble in excess of NH_4OH solution	CU^{2+} may be present
	iii. To the third portion add Barium Chloride solution followed by dilute hydrochloric acid.	White ppt was formed insoluble in HCl	SO_4^{2-} present, confirmed
	iv. To the forth portion add potassium ferrocyanide.	Reddish-brown gelatinous ppt was formed	CU^{2+} present, confirmed

Conclusion:

The Cation present in sample H is **CU^{2+}**

The Anion present in sample H is **SO_4^{2-}**

Compound H is **$CUSO_4$**

Practical 39

Sample M is a simple salt containing one cation and one anion. Carry out experiments described below. Record carefully your observations and appropriate inferences and hence identify the cation and anion present in the sample.

S/n	Experiment	Observation	Inferences
(a)	Appearance of sample M		
(b)	Heat a little amount of M in a dry test tube		
(c)	To a little M in a test tube add dilute HCl		
(d)	To a little M in a test tube add distilled water and stir it		
(e)	To a solution of sample M add KOH solution and warm it.		
(f)	To the solution of sample M add $MgSO_4$ solution		

Conclusion.

The cation in sample M is ....and the anion is ....

The molecular formula of salt M is ....

Solution

Table of Results

S/n	Experiment	Observation	Inferences
(a)	Appearance of sample M	-White crystalline substance	-Transition elements (Fe^{2+},Fe^{3+} ,Cu^{2+}) absent
(b)	Heat a little amount of M in a dry test tube	-White sublimate and ammonia gas detected	-NH_4^+ may be present
(c)	To a little M in a test tube add dilute HCl	-Effervescence and gas evolve which turn lime water milky- CO_2 gas evolved	-HCO_3^- or CO_3^{2-} may be present
(d)	To a little M in a test tube add distilled water and stir it	-Soluble in water	-Insoluble salts absent
(e)	To a solution of sample M add KOH solution and warm it.	-Gas with chocking smell and which turn damp litmus paper blue on warming,NH_3 gas evolves	-NH_4^+ may be present
(f)	To the solution of sample M add $MgSO_4$ solution	-White ppt was formed	-CO_3^{2-} present, confirmed

Conclusion:
The cation in sample **M** is **NH_4^+** and the anion is **CO_3^{2-}**

The molecular formula of salt **M** is **$(NH_4)_2$ CO_3**