# MOLARITY

1. You are provided with the following.

BA1 is a solution of sodium carbonate

BA2 is 0.2M hydrochloric acid solution.

In this experiment you are required to determine the concentration of sodium carbonate in moles per liter (molarity).

Procedure: pipette 20 or 25$cm^3$ of sodium carbonate solution in to a conical flask. Add 2drops of methyl orange indicator then titrate the mixture with BA2 from the Burette until the end point is reached.

Record your results in the table below and repeat titration until you obtain consistent results.

Volume of the pipette used……$cm^3$

| | | | |
|---|---|---|---|
| Final Burette reading $cm^3$ | | | |
| Initial burette reading $cm^3$ | | | |
| Volume of BA2 used $cm^3$ | | | |

Titre values of BA2 ……, ……

Average volume of BA2 ……

a) Find the number of moles of hydrochloric acid in BA2 that reacted.

.....

.....

.....

.....

b) Write the equation for the reaction

.....

.....

.....

.....

c) Find the concentration of sodium carbonate in moles per liter (molarity)

.....

.....

.....

.....

.....

.....

.....

.....

2. You are provided with the following

BA1 is sodium hydroxide solution

BA2 is 0.05M sulphuric acid solution.

In this experiment you are required to determine the concentration in moles per litre of sulphuric acid (molarity).

Procedure: pipette 20 or 25$cm^3$ of BA1 in to a clean conical flask. Add 2drops of phenolphthalein indicator titrate the mixture with BA2 from the Burette until the end point is reached. Record your results in the table below and repeat titration until you obtain consistent results;

Volume of the pipette used……$cm^3$

| | | | |
|---|---|---|---|
| Final burrete reading $cm^3$ | | | |
| Initial Burrete reading $cm^3$ | | | |
| Volume of BA2 used $cm^3$ | | | |

Titre values of BA2 ……, ……

Average volume of BA2 used ……

a) Determine the number of moles of BA2 that reacted

.....

.....

.....

.....

.....

b) Write the equation for the reaction.

.....

.....

.....

c) Determine the concentration of sodium hydroxide in moles per litre.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

3. You are provided with the following.

BA1 is 0.2M Sodium hydroxide solution.

BA2 is oxalic acid solution.

In this experiment you are required to determine the concentration of oxalic acid in the moles per liter (molarity)

Procedure; pipette 20 or 25$cm^3$ of BA1 in to a conical flask add 2 drops of phenolphthalein indicator titrate the mixture with BA2 from the burette until the end point is reached.

Record your results in the table below and repeat titration until you obtain consistent results.

Volume of the pipette used…….. $cm^3$.

| | | | |
|---|---|---|---|
| Final Burette reading $cm^3$ | | | |
| Initial Burette readings $cm^3$ | | | |
| Volume of BA2 used in $cm^3$ | | | |

Titre volumes of BA2 ……., ……..

Average volumes of BA2 ……..……..

a). Determine the number of moles of sodium hydroxide in BA1 that reacted

.....

.....

.....

.....

.....

.....

b).Write the equation for the reaction between BA1 and BA2

.....

.....

.....

.....

.....

c) .Determine the concentration of oxalic acid in moles per liter (molarity)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

4. You are provided with the following.

BA1 is 0.1M sodium hydroxide solution.

BA2 is hydrochloric acid solution.

In this experiment you are required to determine the concentration in moles per litre of hydrochloric acid.

Procedure: pipette 20 or 25cm$^3$ of BA1 in to a conical flask add 2drops of phenolphthalein indicator then titrate the mixture with BA2 from the burrete until the end point is reached. Record your results in the table below and repeat titration until you obtain consistent results.

Volume of the pipette used……..$cm^3$

| | | | |
|---|---|---|---|
| Final Burrete reading $cm^3$ | | | |
| Initial Burrete reading $cm^3$ | | | |
| Volume of BA2 used $cm^3$ | | | |

Titre values of BA2……, ……..

Average volume of BA2 ……..……

a) Determine the number of moles ox BA1 that reacted.

……

……

……

……

b) Write the equation for the reaction between BA1 and BA2

……

……

……

…… Determine the concentration of hydrochloric acid in BA2 in moles per litre (molarity)

……

……

……

……

……

……

## PERCENTAGE PURITY AND IMPURITY

1. You are provided with the following

BA1 is made by dissolving 12.7g of the impure sodium carbonate in one litre of solution.

BA2 is 0.2M Hydrochloric acid solution.

In this experiment, you are required to determine the percentage purity and impurity in sodium carbonate.

Procedure: pipette 20 or 25$cm^3$ of BA1 into a conical flask, add 2 drops of methyl orange indicator then titrate the mixture with BA2 from the burrete until the end point is reached. Record your results in the table below and repeat titration until you obtain consistent results.

Volume of the pipette used.....$cm^3$

| | | | |
|---|---|---|---|
| Final Burrete reading $cm^3$ | | | |
| Initial Burette reading $cm^3$ | | | |
| Volume of BA2 used $cm^3$ | | | |

Titre values of BA2....., .....

Average volume of BA2.....

a) Find the number of moles of Hydrochloric acid in BA2 that reacted

.....

.....

.....

.....

.....

b) Write the equation for the reaction between BA1 and BA2

.....

.....

.....

c) Determine the concentration of sodium carbonate in moles per litre (molarity)

.....

.....

.....

.....

.....

.....

.....

..... Determine the percentage purity and impurity of sodium carbonate (Na=23, C=12, O=16)

.....

.....

.....

.....

.....

.....

2. You are provided with the following

BA1 is made by dissolving 6.4g of the impure sodium carbonate in 500$cm^3$ of water to make a solution.

BA2 is 0.2M Hydrochloric acid solution.

In this experiment, you are required to determine the percentage purity and impurity in sodium carbonate.

Procedure: pipette 20 or 25$cm^3$ of BA1 into a conical flask, add 2 drops of methyl orange indicator then titrate the mixture with BA2 from the burrete until the end point is reached. Record your results in the table below and repeat titration until you obtain consistent results.

Volume of the pipette used_____$cm^3$

| | | | |
|---|---|---|---|
| Final Burrete reading $cm^3$ | | | |
| Initial Burette reading $cm^3$ | | | |
| Volume of BA2 used $cm^3$ | | | |

Titre values of BA2....., .....

Average volume of BA2.....

a) Find the number of moles of Hydrochloric acid in BA2 that reacted

.....

.....

.....

.....

.....

b) Write the equation for the reaction between BA1 and BA2

.....

.....

.....

c) Determine the concentration of sodium carbonate in moles per litre (molarity)

.....

.....

.....

.....

.....

.....

.....

.....

d) Determine the percentage purity and impurity of sodium carbonate (Na=23, C=12, O=16)

.....

.....

.....

.....

.....

.....

3. You are provided with the following

BA1 is made by dissolving 3.175g of the impure sodium carbonate in 250$cm^3$ of water to make a solution.

BA2 is 0.2M Hydrochloric acid solution.

In this experiment, you are required to determine the percentage purity and impurity in sodium carbonate.

Procedure: pipette 20 or 25$cm^3$ of BA1 into a conical flask, add 2 drops of methyl orange indicator then titrate the mixture with BA2 from the burrete until the end point is reached. Record your results in the table below and repeat titration until you obtain consistent results.

Volume of the pipette used_____$cm^3$

| | | | |
|---|---|---|---|
| Final Burrete reading $cm^3$ | | | |
| Initial Burette reading $cm^3$ | | | |
| Volume of BA2 used $cm^3$ | | | |

Titre values of BA2.....

Average volume of BA2.....

a) Find the number of moles of Hydrochloric acid in BA2 that reacted

.....

.....

.....

.....

.....

b) Write the equation for the reaction between BA1 and BA2

.....

.....

.....

c) Determine the concentration of sodium carbonate in moles per litre (molarity)

.....

.....

.....

.....

.....

.....

.....

.....

d) Determine the percentage purity and impurity of sodium carbonate (Na=23, C=12, O=16)

.....
.....

.....

.....

.....

.....

4. You are provided with the following.

BA1 is made by dissolving 10.2g of the impure Sodium hydroxide in one litre.

BA2 is 0.1M sulphuric acid solution.

In this experiment, you are required to determine the percentage purity and impurity in sodium hydroxide.

Procedure: Pipette 20 or 25$cm^3$ of BA1 into a conical flask, add 2 drops of phenolphthalein indicator then titrate the mixture with BA2 from the burrete until the end point is reached. Record your results in the table below and repeat titration until you obtain consistent results

Volume of the pipette used .....$cm^3$

| | | | |
|---|---|---|---|
| Final burrete reading $cm^3$ | | | |
| Initial burrete reading $cm^3$ | | | |
| Volume of BA2 used $cm^3$ | | | |

Titre values of BA2 ....., .....

Average volume of BA2.....

a) Find the number of moles of BA2 that reacted

.....

.....

.....

.....

.....

b) Write the equation for the reaction

.....

.....

.....

c) Find the concentration of sodium hydroxide in moles per $dm^3$

.....

.....

.....

.....

.....

.....

.....

.....

d) Find the percentage purity and percentage impurity of sodium hydroxide (Na=23, O=16, H=1)

.....

.....

.....

.....

.....

.....

5. You are provided with the following.

BA1 is made by dissolving 5.3g of the impure Sodium hydroxide in 500$cm^3$ of water to make a solution.

BA2 is 0.1M sulphuric acid solution.

In this experiment, you are required to determine the percentage purity and impurity in sodium hydroxide.

Procedure: Pipette 20 or 25$cm^3$ of BA1 into a conical flask, add 2 drops of phenolphthalein indicator then titrate the mixture with BA2 from the burrete until the end point is reached. Record your results in the table below and repeat titration until you obtain consistent results

Volume of the pipette used .....$cm^3$

| | | | |
|---|---|---|---|
| Final burrete reading $cm^3$ | | | |
| Initial burrete reading $cm^3$ | | | |
| Volume of BA2 used $cm^3$ | | | |

Titre values of BA2 ....., .....

Average volume of BA2.....

e) Find the number of moles of BA2 that reacted

.....

.....

.....

.....

.....

f) Write the equation for the reaction

.....

.....

.....

g) Find the concentration of sodium hydroxide in moles per $dm^3$

.....

.....

.....

.....

.....

.....

.....

.....

h) Find the percentage purity and percentage impurity of sodium hydroxide (Na=23, O=16, H=1)

.....

.....

.....

.....

.....

.....

6. You are provided with the following.

BA1 is made by dissolving 2.7g of the impure Sodium hydroxide in 250$cm^3$ of water to make a solution.

BA2 is 0.1M sulphuric acid solution.

In this experiment, you are required to determine the percentage purity and impurity in sodium hydroxide.

Procedure: Pipette 20 or 25$cm^3$ of BA1 into a conical flask, add 2 drops of phenolphthalein indicator then titrate the mixture with BA2 from the burrete until the end point is reached. Record your results in the table below and repeat titration until you obtain consistent results

Volume of the pipette used .....$cm^3$

| | | | |
|---|---|---|---|
| Final burrete reading $cm^3$ | | | |
| Initial burrete reading $cm^3$ | | | |
| Volume of BA2 used $cm^3$ | | | |

Titre values of BA2 ....., .....

Average volume of BA2.....

i) Find the number of moles of BA2 that reacted

.....

.....

.....

.....

.....

j) Write the equation for the reaction

.....

.....

.....

k) Find the concentration of sodium hydroxide in moles per $dm^3$

.....

.....

.....

.....

.....

.....

.....

.....

l) Find the percentage purity and percentage impurity of sodium hydroxide (Na=23, O=16, H=1)

.....

.....

.....

.....

.....

.....

7. You are provided with the following

BA1 is made by dissolving 13.4g of a mixture of sodium chloride and sodium carbonate in one litre.

BA2 is 0.2M hydrochloric solution.

In the experiment you are required to determine the percentage by mass of sodium chloride and percentage of sodium carbonate in the mixture.

Procedure: pippete 20 or 25$cm^3$ of BA1 in to a conical flask add 2drops of methyl orange indicator then

titrate the mixture with BA2 from the Burrete until the end point is reached.

Record your results in the table below and repeat titration until you obtain the consistent results.

Volume of the reading used _____ $cm^3$

| | | | |
|---|---|---|---|
| Final Burette reading $cm^3$ | | | |
| Initial Burrete reading $cm^3$ | | | |
| Volume of BA2 used $cm^3$ | | | |

Titre values of BA2 ……,……..

Average volume of BA2 …….

a) Find the number of moles of hydrochloric acid in BA2 that reacted.

……

……

……

……

……

b) Write the equation for the reaction between BA1 and BA2.

……

……

……

……

C) Find the concentration of BA1 in moles per $dm^3$ (molarity)

……

……

……

……

……

……

……

d) Find the percentage by mass of sodium chloride and sodium carbonate in the mixture.

(Na=23, C=12, O=16)

……

……

……

……

……

……

……

8. You are provided with the following

BA1 is made by dissolving 13.6g of a mixture of Sodium sulphate and Sodium hydroxide in one litre.

BA2 is 0.05M sulphuric acid solution.

In this experiment, you are required to determine the percentage by mass of sodium sulphate and percentage of sodium hydroxide in the mixture.

Procedure: pipette 20 or 25$cm^3$ of BA1 in to a conical flask add 2drops of phenolphthalein indicator then titrate the mixture with BA2 from the Burette until the end point is reached. Record your results in the table below and repeat titration until you obtain consistent results.

Volume of the pipette used ……$cm^3$

| | | | |
|---|---|---|---|
| Final Burrete reading $cm^3$ | | | |
| Initial Burrete reading $cm^3$ | | | |
| Volume of BA2 used $cm^3$ | | | |

Titre values of BA1 ……., …….

Average volume of BA2 ……..

a) Find the number of moles of BA2 that reacted.

……

……

……

……

b) Write the equation for the reaction that took place.

……

……_

……

……_

c) Find the concentration of sodium – hydroxide in moles per liter (molarity)

……

……_

……

……_

……

……

……_ d) Find the percentage by mass of sodium sulphate and percentage of sodium hydroxide in the mixture.

(Na=23, O=16, H=1).

……

……

……

……

……

……

……

……

## WATER OF CRYSTALLISATION

1. You are provided with the following

BA1 is made by dissolving 28.6g of hydrated sodium carbonate $Na_2CO_3.nH_2O$ in one litre.

BA2 is 0.2M Hydrochloric acid. In this experiment, you are required to determine the value of n (water of crystallization) in hydrated sodium carbonate.

Procedure: pipette 20 or 25$cm^3$ of BA1 into a conical flask, add 2 drops of methyl orange indicator then titrate the mixture with BA2 from the burette until the end point is reached. Record your results in the table below and repeat titration until you obtain consistent results.

Volume of the pipette used.....$cm^3$

| | | | |
|---|---|---|---|
| Final Burette reading $cm^3$ | | | |
| Initial Burette reading $cm^3$ | | | |
| Volume of BA2 used $cm^3$ | | | |

Titre values of BA2....., .....

Average volume of BA2.....

d) Find the number of moles of BA2 that reacted

.....

.....

.....

.....

.....

e) Write the equation for the reaction between BA1 and BA2

.....

.....

.....

f) Determine the concentration of sodium carbonate in moles per litre

.....

.....

.....

.....

.....

.....

.....

.....

g) Deduce the relative formula mass of Hydrated sodium carbonate $Na_2CO_3.nH_2O$ and Hence find the value of n in the salt (Na=23, C=12, O=16, H=1)

.....

.....

.....

.....

.....

.....

2. You are provided with the following

BA1 is made by dissolving 14.3g of hydrated sodium carbonate $Na_2CO_3.nH_2O$ in 500$cm^3$ of water to make a solution.

BA2 is 0.2M Hydrochloric acid. In this experiment, you are required to determine the value of n (water of crystallization) in hydrated sodium carbonate.

Procedure: pipette 20 or 25$cm^3$ of BA1 into a conical flask, add 2 drops of methyl orange indicator then titrate the mixture with BA2 from the burrete until the end point is reached. Record your results in the table below and repeat titration until you obtain consistent results.

Volume of the pipette used.....

$cm^3$

| | | | |
|---|---|---|---|
| Final Burrete reading $cm^3$ | | | |
| Initial Burette reading $cm^3$ | | | |
| Volume of BA2 used $cm^3$ | | | |

Titre values of BA2....., .....

Average volume of BA2.....

a) Find the number of moles of BA2 that reacted

.....

.....

.....

.....

.....

b) Write the equation for the reaction between BA1 and BA2

.....

.....

c) Determine the concentration of sodium carbonate in moles per litre

.....

.....

.....

.....

.....

.....

.....

.....

d) Deduce the relative formula mass of Hydrated sodium carbonate $Na_2CO_3.nH_2O$ and Hence find the value of n in the salt (Na=23, C=12, O=16, H=1)

.....

.....

.....

.....

.....

.....

3. You are provided with the following

BA1 is made by dissolving 7.15g of the hydrated sodium carbonate $Na_2CO_3.nH_2O$ in 250$cm^3$ of water to make a solution.

BA2 is 0.2M Hydrochloric acid. In this experiment, you are required to determine the value of n (water of crystallization) in hydrated sodium carbonate.

Procedure: pipette 20 or 25$cm^3$ of BA1 into a conical flask, add 2 drops of methyl orange indicator then titrate the mixture with BA2 from the burrete until the end point is reached. Record your results in the table below and repeat titration until you obtain consistent results.

Volume of the pipette used.....$cm^3$

| | | | |
|---|---|---|---|
| Final Burrete reading $cm^3$ | | | |
| Initial Burette reading $cm^3$ | | | |
| Volume of BA2 used $cm^3$ | | | |

Titre values of BA2....., .....

Average volume of BA2.....

a) Find the number of moles of BA2 that reacted

.....

.....

.....

.....

.....

b) Write the equation for the reaction between BA1 and BA2

.....

.....

.....

c) Determine the concentration of sodium carbonate in moles per litre

.....

.....

.....

.....

.....

.....

.....

.....

d) Deduce the relative formula mass of Hydrated sodium carbonate $Na_2CO_3.nH_2O$ and Hence find the value of n in the salt (Na=23, C=12, O=16, H=1)

.....

.....

.....

.....

.....

.....

4. You are provided with the following

BA1 is 0.2M sodium hydroxide solution.

BA2 is made by dissolving 12.6g of hydrated acid $H_2CO_4$. X $H_2O$ in one litre.

In this experiment you are required to determine the value of X (water of crystallization) in the acid

Procedure: pipette 20 or 25$cm^3$ of BA1 into a conical flask, add 2 drops of phenolphthalein indicator then titrate the mixture with BA2 from the burrete until the end point is reached. Record your results in the table below and repeat titration until you obtain consistent results.

Volume of the pipette used.....$cm^3$

| | | | |
|---|---|---|---|
| Final Burrete reading $cm^3$ | | | |
| Initial Burette reading $cm^3$ | | | |
| Volume of BA2 used $cm^3$ | | | |

Titre values of BA2....., .....

Average volume of BA2.....

a) Determine the number of moles of sodium hydroxide is BA1 used .....

.....

.....

.....

.....

b) Write the equation for the reaction between BA1 and BA2

.....

.....

.....

c) Determine the concentration of the acid in moles per $dm^3$ (molarity)

.....

.....

.....

.....

.....

.....

.....

.....

d) Find the mass of one mole of the hydrated acid (molecular weight) and hence deduce the value of X in the acid. (H=1C=12,O=16)

.....

.....

.....

.....

.....

.....

5. You are provided with the following

BA1 is 0.2M sodium hydroxide solution.

BA2 is made by dissolving 6.3g of hydrated acid $H_2C_2O_4.XH_2O$ in 500$cm^3$ of water to make a solution.

In this experiment you are required to determine the value of X (water of crystallization) in the acid

Procedure: pipette 20 or 25$cm^3$ of BA1 into a conical flask, add 2 drops of phenolphthalein indicator then titrate the mixture with BA2 from the burrete until the end point is reached. Record your results in the table below and repeat titration until you obtain consistent results.

Volume of the pipette used_____$cm^3$

| | | | |
|---|---|---|---|
| Final Burrete reading $cm^3$ | | | |
| Initial Burette reading $cm^3$ | | | |
| Volume of BA2 used $cm^3$ | | | |

Titre values of BA2....., .....

Average volume of BA2.....

e) Determine the number of moles of sodium hydroxide is BA1 used

.....

.....

.....

.....

.....

f) Write the equation for the reaction between BA1 and BA2

.....

.....

.....

g) Determine the concentration of the acid in moles per $dm^3$ (molarity)

.....

.....

.....

.....

.....

.....

.....

.....

h) Find the mass of one mole of the hydrated acid (molecular weight) and hence deduce the value of X in the acid. (H=1C=12,O=16)

.....

.....

.....

.....

.....

.....

6. You are provided with the following

BA1 is 0.2M sodium hydroxide solution. BA2 is made by dissolving 3.15g of hydrated acid $H_2C_2O_4$. X $H_2O$ in 250$cm^3$ of water to make a solution..

In this experiment you are required to determine the value of X (water of crystallization) in the acid

Procedure: pipette 20 or 25$cm^3$ of BA1 into a conical flask, add 2 drops of phenolphthalein indicator then titrate the mixture with BA2 from the burrete until the end point is reached. Record your results

in the table below and repeat titration until you obtain consistent results.

Volume of the pipette used_____ $cm^3$

| | | | |
|---|---|---|---|
| Final Burrete reading $cm^3$ | | | |
| Initial Burette reading $cm^3$ | | | |
| Volume of BA2 used $cm^3$ | | | |

Titre values of BA2....., .....

Average volume of BA2.....

i) Determine the number of moles of sodium hydroxide is BA1 used .....

.....

.....

.....

.....

j) Write the equation for the reaction between BA1 and BA2

.....

.....

.....

k) Determine the concentration of the acid in moles per $dm^3$ (molarity)

.....

.....

.....

.....

.....

.....

.....

.....

l) Find the mass of one mole of the hydrated acid (molecular weight) and hence deduce the value of X in the acid. (H=1C=12,O=16)

.....

.....

.....

.....

.....

.....

## MOLE RATIO

1. You are provided with the following

BA1 is 0.1M solution of base Q

BA2 is 0.05M solution of an acid P

In this experiment you are required to determine the mole ratio between Q and P. (stochiometry).

Procedure: pipette 20 or 25$cm^3$ of BA1 into a conical flask and add 2 drops of phenolphthalein indicator then titrate the mixture with BA2 from the burrete until the end point is reached. Record your results in the table below and repeat titration until you obtain consistent results.

Volume of the pipette used.....$cm^3$

| | | | |
|---|---|---|---|
| Final Burrete reading $cm^3$ | | | |
| Initial Burette reading $cm^3$ | | | |
| Volume of BA2 used $cm^3$ | | | |

Titre values of BA2....., .....

Average volume of BA2.....

a) Find the number of moles of Q in BA1 that reacted

.....

.....

.....

.....

.....

b) find the number of moles of P in BA2

.....

.....

.....

.....

.....

c) determine the mole ratio between Q and P

.....

.....

.....

.....

.....

2. You are provided with the following

BA1 is 0.2M solution of base R

BA2 is made by dissolving 9.8g of an acid K in one litre.

In this experiment you are required to determine the mole ratio between Q and P. (stoichiometry).

Procedure: pipette 20 or 25$cm^3$ of BA1 into a conical flask and add 2 drops of phenolphthalein indicator then titrate the mixture with BA2 from the burrete until the end point is reached. Record your results in the table below and repeat titration until you obtain consistent results.

Volume of the pipette used.....$cm^3$

| | | | |
|---|---|---|---|
| Final Burrete reading $cm^3$ | | | |
| Initial Burette reading $cm^3$ | | | |
| Volume of BA2 used $cm^3$ | | | |

Titre values of BA2....., .....

Average volume of BA2.....

a) Find the number of moles of R in BA1 that reacted

.....

.....

.....

.....

.....

b) find the number of moles of K in BA2

.....

.....

.....

.....

.....

c) determine the mole ratio between R and K

.....

.....

.....

.....

.....

# BASICITY OF AN ACID

1. You are provided with the following

   BA1 is 0.1 M sodium hydroxide solution

   BA2 is 0.05M solution of an acid $H_nX$.

   In this experiment you are required to determine the Basicity of an acid (value if n) in $H_nX$.

   Procedure; Pippete 20 or 25$cm^3$ of BA1 into a conical flask add 2drops of phenolphthalein indicator then titrate it with BA2 from the Burrete until the endpoint is reached, Record your results in the table below and repeat titration until you obtain consistent results.

   Volume of the Pippete .....

| | | | |
|---|---|---|---|
| Final Burrete reading $cm^3$ | | | |
| Initial Burrete reading $cm^3$ | | | |
| Volume of BA2 used $cm^3$ | | | |

   Liter values of BA2 ....., .....

   Average volume of BA2 .....

   Find the number of moles of Sodium hydroxide in BA1 that reacted

   .....

   .....

.....

.....

.....

b) Find the number of moles of the acid that reacted.

.....

.....

.....

.....

.....

c) Find the value of n in the acid.

.....

.....

.....

.....

2. You are provided with the following

BA1 is 0.2 M sodium hydroxide solution

BA2 is 0.1M solution of an acid $H_nX$.

In this experiment you are required to determine the Basicity of an acid (value if n) in $H_nX$.

Procedure; pipette 20 or 25$cm^3$ of BA1 into a conical flask add 2drops of phenolphthalein indicator then titrate it with BA2 from the Burrete until the endpoint is reached, Record your results in the table below and repeat titration until you obtain consistent results.

Volume of the pipette.....

| | | | |
|---|---|---|---|
| Final Burrete reading $cm^3$ | | | |
| Initial Burrete reading $cm^3$ | | | |

| | | | |
|---|---|---|---|
| Volume of BA2 used $cm^3$ | | | |

Liter values of BA2 ....., .....

Average volume of BA2 .....

Find the number of moles of Sodium hydroxide in BA1 that reacted

.....

.....

.....

.....

.....

.....

b) Find the number of moles of the acid that reacted.

.....

.....

.....

.....

.....

c) Find the value of n in the acid.

.....

.....

.....

.....

3. You are provided with the following

BA1 is 0.3 M sodium hydroxide solution

BA2 is 0.2M solution of an acid $H_nX$.

In this experiment you are required to determine the Basicity of an acid (value if n) in $H_nX$.

Procedure; Pippete 20 or 25$cm^3$ of BA1 into a conical flask add 2drops of phenolphthalein indicator then titrate it with BA2 from the Burrete until the endpoint is reached, Record your results in the table below and repeat titration until you obtain consistent results.

Volume of the Pippete.....

| | | | |
|---|---|---|---|
| Final Burrete reading $cm^3$ | | | |
| Initial Burrete reading $cm^3$ | | | |
| Volume of BA2 used $cm^2$ | | | |

Liter values of BA2 ....., .....

Average volume of BA2 .....

Find the number of moles of Sodium hydroxide in BAA1 that reacted

.....

.....

.....

.....

.....

b) Find the number of moles of the acid that reacted.

.....

.....

.....

.....

.....

c) Find the value of n in the acid.

.....

.....

.....

.....

.....

## THERMO CHEMISTRY

Determination of molar enthalpy of neutralization of hydrochloric acid by NaOH solution

**NOTE:** molar enthalpy of neutralization is the heat change which occurs when one mole of water is formed. When one mole of hydroxide ion from an alkali reacts with one mole of hydrogen ion from an acid.

You are provided with solutions

BA1 which is 0.05M sodium hydroxide solution

BA2 which is 0.5M hydrochloric acid solution

***Method***

- Pipette 20.0 or 25.0$cm^3$ of BA1 into a conical flask
- Add 5$cm^3$of hydrochloric acid from the burrete, stir the mixture using a thermometer and note the final temperature of the mixture
- Repeat the steps 1 and 2 using 10, 15, 20, 25, 30 and 35$cm^3$ of hydrochloric acid
- Record your results in the table below including the initial temperature of hydrochloric acid.

*Results*

Volume of pipette used .....25.0$cm^3$.....

Initial temperature of HCl 23.0$^0$C

| Volume of HCl added($cm^3$) | 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 |
|---|---|---|---|---|---|---|---|---|
| Volume of NaOH added ($cm^{3)}$ | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| Final temperature of mixture($^0$C) | 23.3 | 24.0 | 24.6 | 25.3 | 25.8 | 26.4 | 25.7 | 25.2 |

i) From the table, determine the volume of HCl required to completely neutralize to NaOH, state the temperature at the point of complete neutralize 25.00$cm^3$

ii) Calculate the temperature rise at the point of neutralization

iii) In the table, before adding any acid, ie when volume of HCl is zero, the temperature recorded is the initial temperature of NaOH

iv) Calculate the heat gained by the mixture

v) Determine the moles of HCL that reacted

vi) Determine the molar enthalpy of neutralization of HCl

# RATES OF REACTIONS

To investigate the effect of concentration on the rate of reaction between dilute hydrochloric acid and sodium thiosulphate solution

***Requirements***

2M HCl in a burette

0.15M sodium thiosulphate

Stop clock

***Procedure***

i) Mark a large cross (x) on a piece of white paper

ii) Pour 50$cm^3$ of 2M HCl from the burette into the beakers containing sodium thiosulphate solution and immediately start a stop clock

iii) Look through the solution in the flask at the cross and note the time taken for the cross to disappear

iv) Repeat the experiment using different volumes of thiosulphate as shown and making sure that the volumes are adjusted with distilled water.

**Table**

| Volume of sodium thiosulphate $cm^3$ | Volume of water added | Volume of acid | Time t/s | $1/t(s^{-1})$ |
|---|---|---|---|---|
| 50 | 0 | 50 | | |
| 40 | 10 | 50 | | |
| 30 | 20 | 50 | | |
| 20 | 30 | 50 | | |
| 10 | 40 | 50 | | |

**Question**

a) Plot a graph of volume of thiosulphate (y-axis) against $\frac{1}{t}$ (x-axis)

b) Use your graph to explain how the rate of reaction depends on the concentration of $S_2O_3^{2-}$

c) In this experiment $\frac{1}{t}$ is used as a measure of the rate of reaction. Explain how.

**NB:** 0.15M $NaS_2O_3$ is prepared by dissolving 37.2g of the salt in distilled water and the solution made to $1000cm^3$

## QUALITATIVE ANALYSIS

Qualitative analysis is the systematic identification of chemical constituents of a particular substance in form of ions (cations and anions)

Cations carry positive charges

Anions carry negative charges

### COMMON CATIONS IDENTIFIED

a) Transition metal ions

These appear as coloured Cations and include:-

$Fe^{3+}$, $Fe^{2+}$, $Cu^{2+}$

b) Non-coloured Cations

$Zn^{2+}$, $Pb^{2+}$, $Mg^{2+}$,$Al^{3+}$,$NH_4^+$,$Ca^{2+}$

### COMMON ANIONS IDENTIFIED

$SO_4^{2-}$, $CO_3^{2-}$, $Cl^-$,$NO_3^-$, $SO_3^{2-}$

### PRELINARY TEST

***SOLIDS***

Table 1

| OBSERVATION | INFERENCE |
|---|---|
| Black colour | An oxide or sulphide |
| Yellow colour | Lead(II) oxide or iron(III) salt |
| Green colour | Iron(II) or copper(II) salt |

| | |
|---|---|
| Blue colour | Iron(//) or copper(//) salt |
| Smell of ammonia | Ammonium salt |
| Smell of hydrogen sulphide | Sulphide |
| Smell of sulphur dioxide | sulphite |
| deliquescent | Chloride or nitrate |

**FLAME TESTS**

Place little of the substance on a watch glass, moisten it with pure concentrated hydrochloric acid, and heat little on a clean platinum or alchrome wire. Note the colour of the flame if you think potassium is present at flame through glass.

**Table 2**

| OBSERVATION | INFERENCE |
|---|---|
| Brilliant yellow | Sodium |
| Red | Calcium |
| Blue | Lead |
| Blue-green | Copper |
| Lilac (crimson thru blue glass) | Potassium |

***ACTION OF HEAT ON SOLID***

**Table 3**

| | OBSERVATION | DEDUCTION |
|---|---|---|
| I) | Colourless liquid which turns anhydrous copper (II) sulphate blue forms on cooler parts of the tube | Solid contains water of crystallization of hydrated salt |
| II) | White sublimate forms | $NH_4^+$ present |
| III) | Cracking sound is made | $Pb^{2+}$ |
| IV) | Residue yellow when hot and white on cooling | ZnO |
| V) | Residue yellow when hot and colour persists on cooling | PbO |

| | | |
|---|---|---|
| VI) | Residue black | CuO, FeO, NiO suspected |

*GAS*

**Table 4**

| GAS | COLOUR | SMELL | ACTION WITH SPLINT | LITMUS |
|---|---|---|---|---|
| Chlorine | Greenish Yellow | Irritating characteristic | Doesn't burn or support combustion | Turn Red then is bleached |
| Hydrogen chloride or (bromine) | Colourless misty fumes in damp air | Irritating | Doesn't burn or support combustion | Red |
| Nitrogen dioxide | Reddish brown | Irritating characteristic | Doesn't burn or support combustion | Red |
| Nitric acid vapour | Pale yellow fumes | Irritating | Split burns | Red |
| Sulphur dioxide | White fumes | Irritating | Doesn't burn or support | Red |

| GAS | COLOUR | SMELL | ACTION WITH SPLINT | LITMUS |
|---|---|---|---|---|
| Hydrogen sulphide | None | Rotten eggs | Burns with blue flame, depositing yellow sulphur on cold surface | Faint red |
| Ammonia | None | Chocking characteristics | Doesn't burn or support combustion | Blue |
| Hydrogen | None | None(if pure) | Burns with blue | None |

| | | | | |
|---|---|---|---|---|
| | | | flame if mixed with air | |
| Oxygen | None | None | Relights glowing splint | None |
| Carbon dioxide | None | Faint(not easy to detect) | Doesn't burn or support combustion | Red |
| Water vapour | None | None | Doesn't burn or support combustion | None |
| Nitrogen | None | None | Doesn't burn or support combustion | None |

**NB**: You are advised to test for gas whenever;

i) You heat the solid

ii) You add sodium hydroxide solution to sample and heat

iii) You add acid to the sample

**DISSOLVING A SOLID IN WATER**

It is important to observe whether the substance is soluble, partially soluble or insoluble in water.

If the substance is insoluble or partially soluble then filtering is done.

| **Soluble** | **Insoluble or partially soluble** |
|---|---|
| All nitrates | |
| All common chlorides | AgCl and $PbCl_2$($PbCl_2$ is insoluble in hot water or on warming) |
| All common sulphates | $BaSO_4$,$PbSO_4$, $CaSO_4$ is sparingly soluble |
| $K_2CO_3$, $Na_2CO_3$, $(NH_4)_2CO_3$ | All common carbonates are insoluble. |

**Example**

| **Observation** | **Deduction** |
|---|---|
| Solid dissolves forming a colourless solution | $Al^{3+}$, $Zn^{2+}$, $Mg^{2+}$, $NH_4^+$ |
| Solid dissolves forming a green or pale | $Fe^{2+}$, $Cu^{2+}$ present |

| | |
|---|---|
| green solution | |
| Solid dissolves forming a blue solution | $Cu^{2+}$ present |

*DISSOLVING A SOLID IN WATER AND FILTER*

In this case, you state the colour of residue and filtrate

a) Filtrate

**Table 5**

| OBSERVATION | DEDUCTION |
|---|---|
| Filtrate is colourless (not colourless solution or suspension) | $Al^{3+}$, $Zn^{2+}$, $Pb^{2+}$, $Mg^{2+}$, $Cal^{2+}$ or $Ba^{2+}$ present<br>$Ba^{2+}$, present |
| Filtrate is blue | $Cu^{2+}$ present |
| Filtrate is green | $Cu^{2+}$, $Fe^{2+}$ present |
| Filtrate green, turn brown/yellow at surface on standing | $Fe^{2+}$, present, oxidized to $Fe^{3+}$ |
| Filtrate is brown/yellow | $Fe^{3+}$, present |

**Residue**

**Table 6**

| OBSERVATION | DEDUCTION |
|---|---|
| Residue is white (not white solution or suspension) | $Al^{3+}$, $Zn^{2+}$, $Pb^{2+}$, $Mg^{2+}$ present |
| Residue is blue | $Cu^{2+}$ present |
| Residue is green | $Cu^{2+}$, $Fe^{2+}$ present |
| Residue green, turn brown/yellow at surface on standing | $Fe^{2+}$, present, oxidized to $Fe^{3+}$ |
| Residue is brown/yellow | $Fe^{3+}$, present |

*REACTION WITH SODIUM CARBONATE SOLUTION*

**Table 7**

| OBSERVATION | DEDUCTION |
|---|---|
| No observable change | $Pb^{2+}$, present |
| White precipitate forms and a colourless acidic gas which turns lime water milky is given off | The gas is $CO_2$<br>Therefore $Al^{3+}$ confirmed present |
| A colourless gas which turns red litmus paper blue is given off (on warming or cold) NB. Here no ppt is formed | The gas is $NH_3$<br>Therefore $NH_4$ confirmed present |
| White precipitate is formed | $Zn^{2+}$, $Mg^{2+}$,( $Ca^{2+}$, $Ba^{2+}$) present |
| Blue/dirty blue precipitate turns black on heating | $Cu^{2+}$ confirmed present |
| Red brown/rust brown precipitate forms and a colourless acidic gas which turns lime water milky is given off | The gas is $CO_2$<br>Therefore $Fe^{2+}$, confirmed present |
| Green precipitate forms, insoluble in excess (No effervescence) | $Fe^{2+}$ confirmed present |

*ACTION OF SODIUM HYDROXIDE SOLUTION*

This tests for cations only

**Table 8**

| OBSERVATION | DEDUCTION |
|---|---|
| White precipitate, insoluble in excess | $Ca^{2+}$, $Mg^{2+}$ present |
| White precipitate soluble in excess forming colourless solution | $Pb^{2+}$, $Zn^{2+}$, $Al^{3+}$present |
| Blue precipitate, insoluble in excess, or ppt turns black on heating | $Cu^{2+}$ present |
| Green precipitate, insoluble in excess, or | $Fe^{2+}$, present, oxidized to $Fe^{3+}$ |

| | |
|---|---|
| ppt turns brown on adding hydrogen peroxide, turns brown on standing | |
| Dark brown precipitate, insoluble in excess | $Fe^{3+}$, present |
| No observable change, on warming a colourless gas which turns red litmus blue evolved (ammonia gas) | $NH_4^+$, present |

**NB:** Hydroxides of lead, zinc and aluminum dissolve in excess sodium hydroxide solution.

$Pb^{2+}(aq) + 2OH^-(aq) \longrightarrow Pb(OH)_{2(s)}$ White

$Pb(OH)_{2(S)} + 2OH^-(aq) \longrightarrow Pb(OH)_4^{2-}(aq)$ plumbate ion

$Zn^{2+}_{(aq)} + 2OH^-_{(aq)} \longrightarrow Zn(OH)_{2(S)}$ White

$Zn(OH)_{2(S)} + 2OH^-(aq) \longrightarrow Zn(OH)_4^{2-}(aq)$ Zincate ion

$Al^{3+}(aq) + 3OH^-(aq) \longrightarrow Al(OH)_{2(s)}$ White

$Al(OH)_{3(S)} + 3OH^-(aq) \longrightarrow Al(OH)_4^-(aq)$ Aluminium ion

$Ca^{2+}(aq) + 2OH^-(aq) \longrightarrow Ca(OH)_{2(s)}$ White

$Cu^{2+}(aq) + 2OH^-(aq) \longrightarrow Cu(OH)_{2(s)}$ Blue

$Fe^{3+}(aq) + 2OH^-(aq) \longrightarrow Fe(OH)_{3(s)}$ Brown/yellow

$NH_4^+(aq) + 3OH^-(aq) \xrightarrow{warm} NH_{3(g)} + H_2O_{(l)}$

$Fe^{3+}(aq) + 2OH^-(aq) \longrightarrow Fe(OH)_{2(s)}$ Green

***ACTIONS WITH AMMONIA SOLUTION***

**Note:** Ammonia solution test for only cations

**Table 9**

| OBSERVATION | DEDUCTION |
|---|---|
| White precipitate formed, insoluble in excess | $Al^{3+}$, $Pb^{2+}$, $Mg^{2+}$ Confirmed present |
| White precipitate forms soluble in excess | $Zn^{2+}$, Confirmed present |

| | |
|---|---|
| Pale blue /blue precipitate formed soluble in excess alkali, forming a deep blue solution | $Cu^{2+}$, Confirmed present |
| Dirty/dark green precipitate formed insoluble in excess alkali, precipitate turns brown on standing | $Fe^{2+}$, confirm present being oxidized to $Fe^{3+}$ |
| Rust brown precipitate forms, insoluble in excess ammonia solution | $Fe^{3+}$, Confirmed present |

Copper(II) Hydroxide dissolve in excess aqueous ammonia to complex compounds.

$Cu(OH)_{2(S)} + 4NH_{3(aq)} \longrightarrow Cu(NH_3)_4^{2+}{}_{(aq)} + 2OH_{(aq)}$

$Zn(OH)_{2(S)} + 4NH_{3(aq)} \longrightarrow Zn(NH_3)_4^{2+}{}_{(aq)} + 2OH_{(aq}$

Tetra-amine copper(II) and tetra-amine zinc ions

### *ACTION OF DILUTE HYDROCHLORIC ACID*

Add cold dilute hydrochloric acid to the solid substance in a test tube. If there is no reaction, warm gently.

**Table 10**

| OBSERVATION | INFERENCE |
|---|---|
| Colourless acidic gas which turns lime water milky evolved | The gas is $CO_2$<br>$CO_3^{2-}$ confirmed present |
| Sulphur dioxide | sulphite |
| Hydrogen sulphide | Sulphide |

$CO_3^{2-}{}_{(s)} + 2H^+_{(aq)} \longrightarrow CO_{2(g)} + H_2O_{(l)}$

$SO_3^{2-}{}_{(s)} + 2H^+_{(aq)} \longrightarrow SO_{2(g)} + H_2O_{(l)}$

$S^{2-}{}_{(s)} + 2H^+_{(aq)} \longrightarrow H_2S_{(g)}$

### *ADDITION OF LEAD NITRATE OR ETHANOATE SOLUTION*

**Note:** These reagents confirm the presence of $SO_4^{2-}$, $CO^{2-}C/^-$ ions

**Table 11**

| OBSERVATION | DEDUCTION |
|---|---|
| White precipitate forms, dissolves on heating and re-precipitate on cooling | $Cl^-$ ion confirmed present |
| White precipitate forms(no effect on heating), which dissolves in nitric acid forming a colourless solution with effervescence of a colourless acidic gas which turns lime water milky | The gas is $CO_2$<br>$CO_3^{2-}$ ions |
| Whiteprecipitate forms (no effect on heating)which is insoluble in nitric acid | $SO_4^{2-}$ confirmed present |

***REACTION WITH POTASSIUM IODIDE SOLUTION***

**Table 12**

| OBSERVATION | DEDUCTION |
|---|---|
| Yellow precipitate formed | $Pb^{2+}$confirmedpresent |
| Brown precipitate forms (form blue solution) | $Cu^{2+}$confirmed present |

**CONFIRMATORY TESTS FOR CATIONS**

| TEST | OBSERVATION | CATION CONFIRMED PRESENT |
|---|---|---|
| Add $1cm^3$ofdiluteNaOH solution and warm | A colourless gas which turns red litmus paper blue is given off | $NH_4^+$ present |
| Add $NH_3$ solution drop wise until in excess | White precipitate forms which dissolves in excess alkali forming a colourless solution | $Zn^{2+}$ present |
| Add few drops of Potassium hexacyano ferrate(II) solution | White precipitate forms | $Zn^{2+}$ present |

| | | |
|---|---|---|
| Add 2-3 drops of $Na_2CO_3$ solution | White precipitate forms | $Zn^{2+}$ present |
| Add 1cm3 of dilute HCl acid | White precipitate soluble on heating and re-appears on cooling | $Pb^{2+}$ present |
| Add 3 drops of Potassium Iodide Solution | Yellow precipitate forms | $Pb^{2+}$ present |
| Add di Sodium hydrogen phosphate solution | White gelatinous precipitate forms | $Al^{3+}$ present |
| Add dilute ammonium solution and ammonium chloride solution followed by a little di Sodium Hydrogen phosphate solution | A white crystalline precipitate forms | $Mg^{2+}$ present |

## SUMMARY OF CONFIRMATORY TESTS FOR $Fe^{2+}$, $Fe^{3+}$ AND $Cu^{2+}$

| | $Fe^{2+}$ | $Fe^{3+}$ | $Cu^{2+}$ |
|---|---|---|---|
| Add 3 drops of Potassium hexacyano ferrate(II) solution | Dark blue precipitate | dark blue precipitate | dark brown precipitate |
| Add Potassium/sodium/ammonium thiocyanate solution | | Deep red/blood red soluton forms | |
| Add sodium carbonate solution | Dirty green precipitate insoluble in excess alkali | Rust brown precipitate insoluble in excess in alkali | Blue precipitate soluble in excess alkali forming deep blue solution |
| [a]dd sodium carbonate | green precipitate | brown precipitate | Blue precipitate |

| | | | |
|---|---|---|---|
| solution | | with effervescence of $CO_2$ gas | turns black on heating |

## CONFIRMATORY ANALYSIS TEST FOR ANIONS

| ION | TEST | OBSERVATION |
|---|---|---|
| $SO_3^{2-}$ | To the solution add dilute HCl and warm | Colourless gas evolved which turns acidified potassium dichromate solution from yellow to green |
| $CO_3^{2-}$ | Add HCl or $HNO_3$ or $H_2SO_4$ | Effervescence of a colourless gas that turns lime water milky |
| $NO_3^-$ | Add concentrated Sulphuric acid and cold freshly prepared aqueous Iron(II) sulphate solution<br>To the cold solution add a few Copper turnings and then concentrated Sulphuric acid and warm | Brown ring formed at the interface<br>Blue solution forms and brown fumes are given off |
| $Cl^-$ | To the solution add dilute Nitric acid and then Silver Nitrate solution followedby dilute Ammonia solution and shake | A white ppt is formed insoluble in the acid. Which dissolves aqueous ammonia forming a colourless solution |
| $SO_4^{2-}$ | To the solution add few drops acidified aqueous Barium Nitrate. To the | White ppt is formed insoluble in the acid |

| | | |
|---|---|---|
| | solution add dilute Hydrochloric acid then Barium chloride solution | White ppt insoluble in the acid |

## HOW TO DIFFERENTIATE BETWEEN $CO_3^{2-}$ AND $HCO^{3-}$

| | |
|---|---|
| To the solution add few solids of Magnesium Sulphate | a) White ppt soluble indicates that $HCO_3$ ions are present<br>b) White ppt insoluble indicates that $CO_3^{2-}$ ions are present |

**Table 13**

| TEST | OBSERVATION | DEDUCTION |
|---|---|---|
| Add dilute HCl acid, $HNO_3$ or $H_2SO_4$ | Effervescence of a colourless acidic gas which turns lime water milky | The gas is $CO_2$<br>$CO_3^{2-}$ confirmed present |
| Add barium chloride then dilute $HNO_3$ | White precipitate soluble in $HNO_3$ with Effervescence of a colourless acidic gas that turns lime water milky | The gas is $CO_2$<br>$CO_3^{2-}$ confirmed present |
| Add barium chloride then dilute HCl acid | White precipitate soluble in $HNO_3$ with Effervescence of a colourless acidic gas that turns lime water milky | The gas is $CO_2$<br>$CO_3^{2-}$ confirmed present |
| Add lead nitrate or lead | White precipitate soluble in | The gas is $CO_2$ |

| | | |
|---|---|---|
| ethanoate solution, then dilute $HNO_3$ | $HNO_3$ with Effervescence of a colourless acidic gas that turns lime water milky | $CO_3^{2-}$ confirmed present |
| Add lead nitrate or or lead ethanoate solution, then dilute nitric acid | White precipitate insoluble in nitric acid | $SO_4^{2-}$ confirmed present |
| Add lead nitrate solution then dilute hydrochloric acid | White precipitate insoluble in hydrochloric acid | $SO_4^{2-}$ confirmed present |
| Add dilute nitric acid then a few drops of silver nitrate solution followed by dilute ammonium solution hydrochloric acid | White precipitate insoluble in nitric acid | $Cl^-$ confirmed present |
| To a solid sample, add concentrated $H_2SO_4$ and heat | Effervescence occurs with misty fumes which turn blue litmus paper red and form dense white fumes which are ammonia | $Cl^-$ confirmed present |

| TEST | OBSERVATION | DEDUCTION |
|---|---|---|
| Add equal volume of freshly prepared iron(II) sulphate solution then the tube is tilted and concentrated sulphuric acid added down the side of the tubes | Two separate layers form a brown ring appear between them | $NO_3^-$ confirmed present |
| Heat the solid sample with concentrated sulphuric acid | Brown fumes (of nitrogen dioxide) forms | $NO_3^-$ confirmed present |
| Add magnesium sulphate solution (or magnesium chloride solution and boil) | No observable change but on boiling a white precipitate forms. **NB**: $CO_3^{2-}$ forms white in cold | $HCO_3^-$ confirmed present |

1. You are provided with substance Q which contains two cations and two anions. You are required to carry out the given tests to identify them and any gas (es) evolved. Record your observations and deduction in the table below.

| Test | Observation | Deduction |
|---|---|---|
| a) Heat a spatula endful of Q in a dry test tube to constant mass. Or until there is no further change. | | |
| b) To another spatula endful of Q put in to a test tube add about $5cm^3$ of distilled water, shake well, filter, and keep both the residue and the filtration. | | |

| | | |
|---|---|---|
| c) Divide the filtrate in to five parts<br>i) To the first part add sodium hydroxide solution drop wise until in excess | | |
| ii) To the second part add aqueous ammonia solution drop wise until in excess. | | |
| iii) To the third part add lead (II) nitrate solution | | |
| iv) To the fourth part add lead(II) nitrate solution followed by dilute nitric acid | | |

| | | |
|---|---|---|
| v) To the fifth part carry out a test of your own choice to identify the Anions in the filtration.<br>……<br>……<br>……<br>…… | | |
| d) To the residue put in to the test tube add dilute nitric acid until there is no further change<br>Then divide the resultant solution in to two parts<br>i) To the first part add sodium hydroxide solution drop wise until in excess. | | |
| d)ii) To the second part add aqueous ammonia solution drop wise until in excess. | | |

| | | |
|---|---|---|
| | | |

Cations in Q ....., .....

Anions in Q ....., .....

2) You are provided with substances X which contains two cations and two anions. You are required to carry out the given tests to identify them and any gase(s) evolved. Record your observations and deductions in the table below.

| Test | Observation | Deduction |
|---|---|---|
| | | |

| | | |
|---|---|---|
| a) Heat a spatula end full of X in a dry test tube to constant mas or until there is no further change. | | |
| b) To another spatula endful of X put in to a test tube add about 5$cm^3$ of distilled water, shake well, filter, and keep both the residue and the filtration. | | |
| c) Divide the filtrate into five parts i) To the first part add sodium hydroxide solution drop wise until in excess | | |

| | | |
|---|---|---|
| ii) To the second part add aqueous ammonia solution drop wise until in excess. | | |
| iii) To the third part add lead(II) nitrate solution | | |
| (iv) To the fourth part add lead (II) nitrate solution followed by dilute nitric acid. | | |
| (v) To the fifth part carry out a test of your choice to identify the Anions in the filtration<br>……<br>……<br>…… | | |

| | | |
|---|---|---|
| ……<br>……<br>…… | | |
| (d) To the residue put in to the test tube add dilute nitric acid until there is no further change. Then divide the resultant solution in two parts.<br>i) To the first part add sodium hydroxide solution drop wise until in excess | | |
| d)To the second part add aqueous ammonia solution drop wise until in excess | | |

Cations in X ....., .....

Anions in X .....

3) You are provided with substances Y which contains two cations and two anions. You are required to carry out the given tests to identify them and any gase(s) evolved. Record your observations and deductions in the table below.

| Test | Observation | Deduction |
|---|---|---|
| a) Heat a spatula end full of Y in a dry test tube to constant mass or until there is no further change. | | |
| b) To another spatula endful of Y put in to a test tube add about $5cm^3$ of distilled water, shake well, filter, and keep both the residue and the filtration. | | |

| | | |
|---|---|---|
| c) Divide the filtrate into five parts i) To the first part add sodium hydroxide solution drop wise until in excess | | |
| ii) To the second part add aqueous ammonia solution drop wise until in excess. | | |
| iii) To the third part add lead(II) nitrate solution | | |

| | | |
|---|---|---|
| (iv) To the fourth part add lead (II) nitrate solution followed by dilute nitric acid. | | |
| (v) To the fifth part carry out a test of your choice to identify the Anions in the filtration<br>……<br>……<br>……<br>…… | | |
| (d) To the residue put in to the test tube add dilute nitric acid until there is no further change. Then divide the resultant solution in two parts.<br>i) To the first part add sodium hydroxide solution drop wise until in excess | | |

| | | |
|---|---|---|
| d)(II) To the second part add aqueous ammonia solution drop wise until in excess | | |

Cations in Y .....,.....

Anions in Y .....

4) You are provided with substances W which contains two cations and two anions. You are required to carry out the given tests to identify them and any gase(s) evolved. Record your observations and deductions in the table below.

| Test | Observation | Deduction |
|---|---|---|
| | | |

| | | |
|---|---|---|
| a) Heat a spatula end full of W in a dry test tube to constant mass or until there is no further change. | | |
| b) To another spatula endful of W put in to a test tube add about 5cm$^3$ of distilled water, shake well, filter, and keep both the residue and the filtration. | | |
| c) Divide the filtrate into five parts i) To the first part add sodium hydroxide solution drop wise until in excess | | |

| | | |
|---|---|---|
| ii) To the second part add aqueous ammonia solution drop wise until in excess. | | |
| iii) To the third part add lead(II) nitrate solution | | |
| (iv) To the fourth part add lead (II) nitrate solution followed by dilute nitric acid. | | |
| (v) To the fifth part carry out a test of your choice to identify the Anions in the filtration<br>……<br>……<br>…… | | |

| | | |
|---|---|---|
| …… | | |
| (d) To the residue put in to the test tube add dilute nitric acid until there is no further change. Then divide the resultant solution in two parts.<br>i) To the first part add sodium hydroxide solution drop wise until in excess | | |
| d)(II) To the second part add aqueous ammonia solution drop wise until in excess | | |

Cations in W ....., .....

Anions in W.....

5) You are provided with substances P which contains two cations and two anions. You are required to carry out the given tests to identify them and any gase(s) evolved. Record your observations and deductions in the table below.

| Test | Observation | Deduction |
|---|---|---|
| | | |

| | | |
|---|---|---|
| a) Heat a spatula end full of P in a dry test tube to constant mass or until there is no further change. | | |
| b) To another spatula endful of P put in to a test tube add about $5cm^3$ of distilled water, shake well, filter, and keep both the residue and the filtration. | | |
| c) Divide the filtrate into five parts i) To the first part add sodium hydroxide solution drop wise until in excess | | |
| ii) To the second part add aqueous ammonia solution drop wise until in excess. | | |

| | | |
|---|---|---|
| iii) To the third part add lead(II) nitrate solution | | |
| (iv) To the fourth part add lead (II) nitrate solution followed by dilute nitric acid. | | |
| (v) To the fifth part carry out a test of your choice to identify the Anions in the filtration<br>……<br>……<br>……<br>……<br>…… | | |
| (d) To the residue put in to the test tube add dilute nitric acid until there is no further change. Then divide the resultant solution in two parts.<br>i) To the first part add sodium hydroxide solution dropwise until in excess | | |

| | | |
|---|---|---|
| d)(II) To the second part add aqueous ammonia solution drop wise until in excess | | |

Cations in P ....., .....

Anions in P .....

6) You are provided with substance A which contains two cations and two anions. You are required to carry out the given tests to identify them any gase(s) evolved. Record your observation and deductions in the table below.

| Test | Observation | Deduction |
|---|---|---|
| a) Heat a spatula endful of A in a dry test tube to constant mass | | |
| b) To another spatula endful of A put into a test tube add about $5cm^3$ of | | |

| | | |
|---|---|---|
| distilled water shake well, filter, and keep both the residue and filtrate. | | |
| c) Divide the filtration in to four parts<br>i) To the first part add sodium hydroxide solution drop wise until in excess. | | |
| ii) To the second part add ammonia solution drop wise until in excess. | | |
| iii) To the third part add lead (ll) nitrate solution followed by dilute nitric acid. | | |
| iv) To the fourth part carryout your own test of your choice to identify the anion in the filtration. | | |

| | | |
|---|---|---|
| d) To the residue put into the test tube add dilute nitric acid solution until there is no further change. Divide the resultant solution into three parts.<br>(i) To the first part add sodium hydroxide solution dropwise until in excess. | | |
| (ii) To the second part add aqueous ammonia solution dropwise until in excess. | | |
| (iii) To the third part carry out your own test to identify the cations in the residue. | | |

Cations in A ....., .....

Anions in A .....

7) You are provided with substance K which contains TWO cations and two Anions. You are required to carry out the given tests to identify them and any gase(s) evolved .Record your observations and deductions in the table below.

| Test | Observation | Deduction |
|---|---|---|

| | | |
|---|---|---|
| a) Heat spatula endful of K in a dry test tube to constant mass. | | |
| b) To another spatula endful of K put into a test tube add about 5cm$^3$ of water shake well, filter keep both the residue and the filtration | | |
| c) Divide the filtrate into four parts add sodium hydroxide solution and heat. | | |

| | | |
|---|---|---|
| ii) To the second part add lead(II) nitrate solution followed by dilute nitric acid solution | | |
| iii) To the third part add lead (II) nitrate solution and warm the mixture. | | |
| v) To the fourth part carryout your own test to identify the anion in the filtration.<br>……<br>……..<br>……<br>……<br>…… | | |

| | | |
|---|---|---|
| ..... | | |
| d) To the residue put into a test tube add dilute nitric acid solution and divide the resultant solution in to three parts<br>i) To the first part add sodium hydroxide solution dropwise until in excess | | |
| ii) To the second part add aqueous ammonia solution dropwise until in excess | | |

| | | |
|---|---|---|
| iii) To the third part carry out your own test to identify the cation in the residue.<br><br>……<br>……<br><br>……<br>……<br><br>…… | | |

Cations in K....., .....

Anions in K .....

8) You are provided with substance R which contains two cations and two anions. You are required to carry out the given tests to identify them and any gase(s) evolved. Record your observation and deductions in the table below.

| **Test** | **Observation** | **Deduction** |
|---|---|---|
| a) heat a spatula endful of R in a dry test tube to constant mass | | |

| | | |
|---|---|---|
| b) To another spatula endful of R put into a test tube add about $5cm^3$ of water, shake well, Filter and keep both the residue and the filtration | | |
| c) Divide the filtration into four parts<br>i) add sodium hydroxide solution and heat | | |
| ii) to the second part add lead nitrate solution followed by dilute nitric acid | | |
| iii) To the third part add lead nitrate solution and heat | | |
| iv) To the fourth part carry out your own test to identify the anions in the filtration | | |

| | | |
|---|---|---|
| ……<br>……<br>……<br>…… | | |
| Put the residue in the test tube add dilute nitric acid solution then Divide the resultant solution in to two parts<br>To the first part add sodium hydroxide solution drop wise until in excess | | |
| ii)To the second part add aqueous ammonia solution drop wise until in excess | | |

Cations in R..... , .....

Anions in R.....

9. You are provided with substance Q which contains two Cations and one anion. You are required to carry out the given tests to identify them and any gase(s) evolved, Record your observations and deductions in the table below

| **Test** | **observation** | **Reduction** |
|---|---|---|

| | | |
|---|---|---|
| a) Heat a spatula end ful of Q in a dry test tube to constant mass | | |
| b) To another spatula endful of Q put into a test tube add about 5cm$^3$ of water. Shake well to make a solution | | |
| c) Divide the resultant solution into five parts<br>i) Add sodium hydroxide solution drop wise until in excess and warm | | |
| ii) To the second part add aqueous ammonia solution drop wise until in excess | | |
| iii) To the third part carry out your own test to identify one of the cation | | |

| | | |
|---|---|---|
| iv) To the fourth part add lead (II) nitrate solution followed by dilute nitric acid | | |
| v) To the fifth part carry out your own test to identify the anion in the filtrate | | |

10. You are provided with substance T which contains two Cations and one anion. You are required to carry out the given tests to identify them and any gase(s) evolved, Record your observations and deductions in the table below

| **Test** | **observation** | **Reduction** |
|---|---|---|
| a) Heat a spatula end ful of T in a dry test tube to constant mass | | |

| | | |
|---|---|---|
| b) To another spatula endful of T put into a test tube add about $5cm^3$ of water. Shake well to make a solution | | |
| c) Divide the resultant solution into five parts<br>i) Add sodium hydroxide solution drop wise until in excess and heat | | |
| ii) To the second part add aqueous ammonia solution drop wise until in excess | | |
| iii) To the third part<br>add lead nitrate solution followed by dilute nitric acid | | |

| | | | |
|---|---|---|---|
| iv) | To the fourth part<br><br>carry out your own test to identify one of the cation | | |
| v) | To the fifth part carry out your own test to identify the anion in the filtrate<br><br>.....<br><br>.....<br><br>.....<br><br>..... | | |

Cations in T..... , .....

Anions in T .....

11. You are provided with substance N which contains two Cations and one anion. You are required to carry out the given tests to identify them and any gase(s) evolved, Record your observations and deductions in the table below

| **Test** | **observation** | **Reduction** |
|---|---|---|

| | | |
|---|---|---|
| a) Heat a spatula end ful of N in a dry test tube to constant mass | | |
| b) To another spatula endful of N put into a test tube add about 5cm$^3$ of water. Shake well to make a solution | | |
| c) Divide the resultant solution into five parts<br>i) Add sodium hydroxide solution drop wise until in excess and heat | | |
| ii) To the second part add aqueous ammonia solution drop wise until in excess | | |

| | | |
|---|---|---|
| iii) To the thirdpart add lead nitrate solution followed by dilute nitric acid | | |
| iv) To the fourth part<br>carry out your own test to identify one of the cation | | |
| v) To the fifth part carry out your own test to identify the anion in the filtrate | | |

Cations in N..... , .....

Anions in N ....., .....

12. You are provided with substance E which contains two Cations and one anion. You are required to carry out the given tests to identify them and any gase(s) evolved, Record your observations and deductions in the table below

| **Test** | **observation** | **Reduction** |
|---|---|---|

| | | |
|---|---|---|
| d) Heat a spatula end ful of E in a dry test tube to constant mass | | |
| e) To another spatula endful of E put into a test tube add about 5cm$^3$ of water. Shake well to make a solution | | |
| f) Divide the resultant solution into five parts<br>vi) Add sodium hydroxide solution drop wise until in excess and heat | | |
| vii) To the second part add aqueous ammonia solution drop wise until in excess | | |

| | | |
|---|---|---|
| viii) To the third part add lead nitrate solution followed by dilute nitric acid | | |
| ix) To the fourth part<br>carry out your own test to identify one of the cation | | |
| x) To the fifth part carry out your own test to identify the anion in the filtrate | | |

Cations in E..... , .....

Anions in E .....

13. You are provided with substance D which contains two Cations and one anion. You are required to carry out the given tests to identify them and any gase(s) evolved, Record your observations and deductions in the table below

| **Test** | **observation** | **Reduction** |
|---|---|---|

| | | |
|---|---|---|
| a) Heat a spatula end ful of D in a dry test tube to constant mass | | |
| b) To another spatula endful of D put into a test tube add about 5cm$^3$ of water. Shake well to make a solution | | |
| c) Divide the resultant solution into five parts<br>i) Add sodium hydroxide solution drop wise until in excess and heat | | |
| To the second part add aqueous ammonia solution drop wise until in excess | | |

| | | |
|---|---|---|
| ii) To the third part add lead nitrate solution followed by dilute nitric acid | | |
| iii) To the fourth part<br>carry out your own test to identify one of the cation | | |
| iv) To the fifth part carry out your own test to identify the anion in the filtrate | | |

Cations in D..... , .....

Anions in D....., .....

14. You are provided with substance X which contains two Cations and one anion. You are required to carry out the given tests to identify them and any gase(s) evolved, Record your observations and deductions in the table below

| **Test** | **observation** | **Reduction** |
|---|---|---|
| a) Heat a spatula end ful of X in a dry test tube to constant mass | | |

| | | |
|---|---|---|
| b) To another spatula endful of X put into a test tube add dilute nitric acid and warm until there is no further change.<br><br>Then add sodiunm hydroxide solution dropwise until in excess.<br><br>Filter, keep bolt the residue and the filtrate | | |
| c) To the filtrate add dilute nitric acid until solution is just acidic then divide it into three parts<br><br>i) To the first part of the acidified filtrate add sodium hydroxide solution dropwise until in excess | | |
| ii) To the second part of the acidified filtrate add ammonia solution dropwise until in excess | | |
| iii) To the third part of the acidified filtrate add, carry out your own test to identify the cations in the filtrate<br><br>.....<br>.....<br>..... | | |

| | | |
|---|---|---|
| ..... ..... | | |
| d) To the residue put into a test tube then dissolve it into dilute nitric acid solution<br>Then divide the resultant solution into three parts.<br>i) To the first part add sodium hydroxide solution drop wise until in excess | | |
| ii) To the second part add iron filling shake well and allow the mixture to stand for about 3 minutes | | |
| iii) To the third part add aqueous ammonia solution drop wise until in excess.<br>.....<br>.....<br>.....<br>..... | | |

Cations in X..... , .....

Anions in X.....

15) You are provided with substances Y which contain two cations and one anions. Carry out the given tests to identify the cations and anions in Y. Record your observations and deductions in the table below.

| Test | Observation | Deduction |
|---|---|---|
| a) Heat a spatula end full of Y in a dry test tube to constant mass | | |
| b) To the residue in( a) above allow to cool then add dilute nitric acid and warm until there is no further exchange then add sodium hydroxide solution drop wise until in excess. Filter , keep both the residue and filtrate | | |
| c) To the filtration add dilute nitric acid until the solution is just acidic then divide it into four parts.<br>i) To the first part add sodium hydroxide solution drop wise until in excess. | | |

| | | |
|---|---|---|
| cii)To the second part of acidified filtrate add ammonia solution drop wise until in excess<br><br>iii To the third part add lead nitrate solution | | |
| iv)To the fourth part add Barium nitrate solution | | |
| d) Dissolve the residue into dilute nitric acid solution. Then divide it into three parts<br>i)To the first part add zinc powder and shake then allow the mixture to stand for about 2minutes | | |
| ii)To the second part add sodium hydroxide solution drop wise until in excess | | |

| | | |
|---|---|---|
| | | |
| iv) To the third part add ammonia solution drop wise in excess. | | |

Cations in y..... , .....

Anions in y.....

16. You are provided with substance F which contains two cations and one anion. You are required to carry out the given tests to identify them and any gase(s) evolved. Record your observations and deductions in the table below.

| | | |
|---|---|---|
| a) Heat a spatula endful of F in a dry test tube until there is no further change | | |
| b) To the another spatula endful of F | | |

| | | |
|---|---|---|
| put into a test tube add dilute nitric acid solution until there is no further change<br><br>then add sodium hydroxide solution drop wise until in excess filter, keep both the residue and the filtration | | |
| c)To the filtration add dilute nitric acid in the solution the divide it into three parts<br><br>i)to the first part add sodium hydroxide solution drop wise until in excess | | |
| iii) To the third part carryout your own test to identify the cations in the filtration.<br><br>……<br><br>……<br><br>……<br><br>……<br>…… | | |

| | | |
|---|---|---|
| d)To the residue put it into a test tube add dilute nitric acid to make a solution Divide the resultant solution in to two parts | | |
| i)To the first part add sodium hydroxide solution drop wise until in excess | | |
| ii) To the second part add aqueous ammonia solution drop wise until in excess | | |

Cations in F..... , .....

Anions in F.....