EXPERIMENT 1(A)

Aim

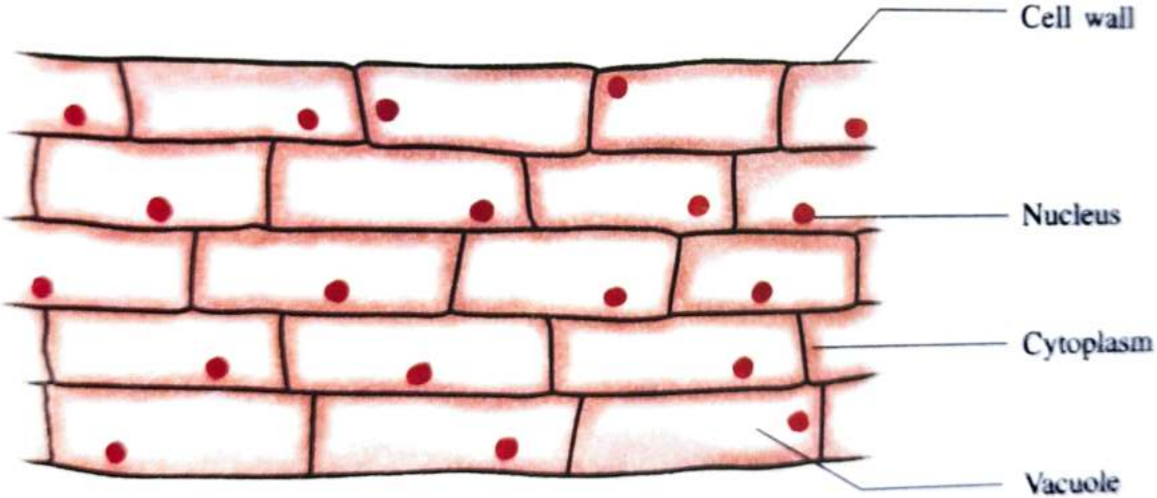
To prepare stained temporary mount of onion peel and to record observations and draw labelled diagrams.

Materials Required

Onion, plane slides, coverslip, watch glass, water, forceps, needles, brush, dropper, blade, safranin, blotting paper, glycerine and microscope.*

Procedure

- Take a piece of onion and with the help of forceps gently pull a thin, transparent peel from its ventral or inner side.
- Keep this peel in watch glass having some water, to avoid dehydration.
- With the help of a dropper add a few drops of safranin stain in the watch glass to stain the peel. Leave the peel for about 3 minutes.
- Now transfer the peel on a clean slide with the help of a brush.
- Cut the portion of the peel to a proper rectangular or square shape of about 2 to 3 mm in size with the help of a blade and a needle.
- Remove the excess of water or stain surrounding the peel, if any, from the slide with the help of a blotting paper.
- Add a drop of glycerine on the slide over the peel and put the coverslip gently to avoid the entry of air bubbles. Care must be taken to avoid the entry of air bubbles and the mounting should be done in the centre of the slide.
- After putting the coverslip, press it slightly with a needle to spread the glycerine over peel properly.
- Remove the excess of glycerine from the corner of the coverslip with the help of a blotting paper by tilting the slide towards one side and then clean the slide.
- Examine the slide under the microscope, first in low power and then in high power.
- Draw a labelled diagram of the cells as seen under the microscope.



Structure of an onion peel

Observations

Features	Observation
Shape of cells	Rectangular cells with regular boundaries
Arrangement of cells	Compactly arranged
Intercellular spaces	Absent
Nucleus	Present on one side of the cell
Cell wall	Present
Vacuole	A big vacuole is present in the center of the cell
Stained portion of cell	Cell wall, cytoplasm and nucleus
Unstained portion of cell	Vacuole

Precautions

- Always hold the slide by its edges to avoid making the slide dirty.
- Always use a fine dropper to add drops of safranin/glycerine.
- A thin and properly stained peel should be selected for final mounting.
- Always use a brush to transfer the peel from watch glass to the slide. Do not use needle.
- The folding of the peel should be avoided.
- The slide and coverslip must be cleaned before use.
- The mounting of the peel should be done in the center of the slide.
- Always put the coverslip gently to avoid the entry of air bubbles.
- Oozing of glycerine should not be avoided.

EXPERIMENT 3(A)

Aim

To study the chemical reaction of iron nail with copper sulphate solution in water, and to classify it as physical change or chemical change.

Materials Required

Iron nails (two), thread, test tubes (two), copper sulphate (2 g), distilled water (20 mL), stand, sand paper.

Basic Principles Involved

- Colour of pure iron metal is greyish.
- Colour of pure copper metal is brownish.
- An aqueous solution of copper sulphate is blue because of the presence of Cu^{2+} ions.
- An aqueous solution of ferrous sulphate is light green because of the presence of Fe^{2+} ions.
- In the activity series of metals iron is above copper, *i.e.*, iron is more reactive than copper.
- When iron is kept in contact with an aqueous solution of copper sulphate, Fe^{2+} ions displace Cu^{2+} ions.
- In the process metallic iron is oxidised to ferrous ion (Fe^{2+}) and cupric ion is reduced to metallic copper.

$$Fe\ (metal) \rightarrow Fe^{2+}(aq) + 2e^- \quad \ldots\ \textit{oxidation}$$

$$Cu^{2+}(aq) + 2e^- \rightarrow Cu\ (metal) \quad \ldots\ \textit{reduction}$$

$$Fe\ (metal) + Cu^{2+}(aq) \rightarrow Fe^{2+}(aq) + Cu\ (metal) \quad \ldots\ \textit{redox}$$

- When sulphate ions (SO_4^{2-}) are also considered, the displacement reaction is represented as:

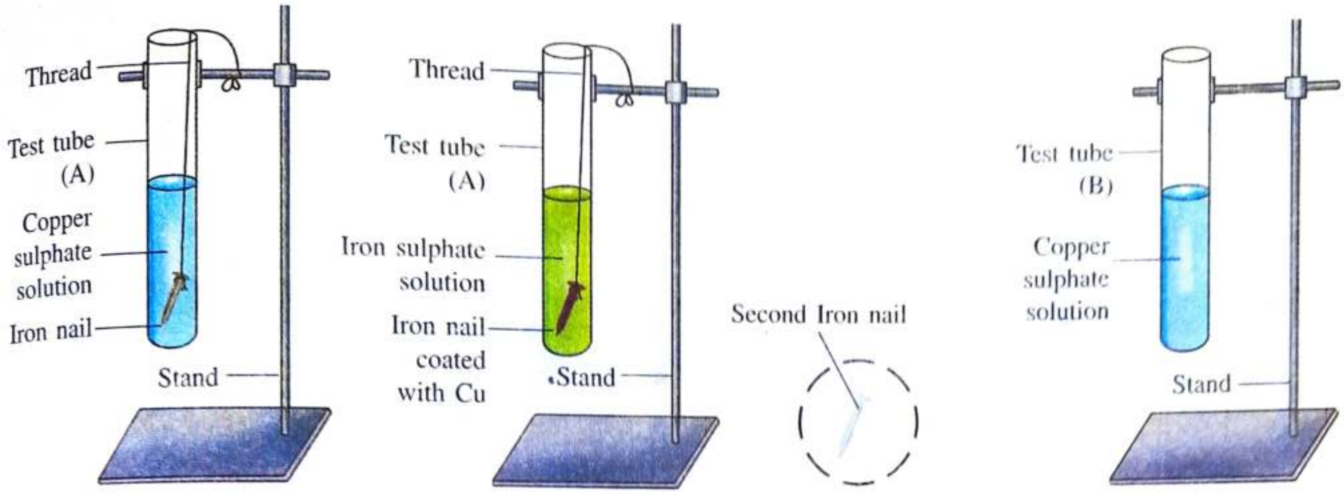
$$Fe + CuSO_4 \rightarrow FeSO_4 + Cu$$

- In this reaction Fe^{2+} ions have displaced Cu^{2+} ions. It is a **single displacement** reaction.

Experimental Steps

- Clean the iron nails by rubbing with sand paper and remove the rust/dust.
- Dissolve 2.0 g of copper sulphate in about 20 mL of water.
- Take 10 mL of the solution in a test tube A and label it "**Solution of copper sulphate**". Keep the test tube on a test tube stand or clamp it in position as shown in the figure.
- Take the second portion of copper sulphate solution in another test tube marked B for comparison.
- Tie one iron nail with a thread and carefully immerse it in the solution of copper sulphate.

- Tie the other end of the thread to stand as shown in the figure below:



(a) Before the experiment (b) After the experiment (For comparison) (For comparison)

- Keep the other nail on a clean sheet of paper for comparison.
- After about 25 minutes remove the iron nail from the solution of the test tube A. Keep it along the side of the second iron nail.
- Record your observations.

System	Observations before experiment	Observations after experiment
• Iron nail	• Iron nail is greyish.	• There is a brown coating on the surface of iron nail.
• Solution	• Copper sulphate is blue in colour.	• The solution has turned light greenish.

Conclusion

- The brown coating on iron nail after some time shows that copper is displaced from solution by iron.
- The greenish colour of the solution shows that Fe^{2+} ions are present in the solution.
- A single displacement reaction has taken place between iron and copper.

  $Fe + CuSO_4 \rightarrow FeSO_4 + Cu$
- Iron is more reactive than copper.

Type of Reaction

- The reaction $Fe + CuSO_4 \rightarrow FeSO_4 + Cu$ is **single displacement** reaction.
- The reaction $Fe\ (s) + Cu^{2+}\ (aq) \rightarrow Fe^{2+}\ (aq) + Cu\ (s)$ is oxidation-reduction (redox) reaction.
- This experiment demonstrates a **chemical change**.

Precautions

- Iron nails should be clean. There should be no grease or oil or dust or rust on iron nails.
- One clean iron nail should be kept outside to compare the change in final colour after the experiment.
- A portion of copper sulphate solution should be kept in another test tube B for comparison of the colours of the solutions before and after dipping the iron nail.
- After completing the experiment the brown coated iron nail should not be touched.
- During the experiment the test tube should not be disturbed.

EXPERIMENT 3(B)

Aim

To study the reaction when magnesium ribbon is burnt in air and to classify it as physical or chemical change.

Materials Required

A strip of magnesium, a pair of tongs (to hold the magnesium ribbon), burner, match box, tray or china dish (to collect the product of burning), litmus solution or litmus paper (to know the nature of the product).

Basic Principles Involved

- Magnesium is an active metal. It combines with the oxygen (of air) to form magnesium oxide.

$$\underset{\substack{\text{Magnesium}\\\text{(element)}}}{2Mg} + \underset{\substack{\text{Oxygen}\\\text{(element)}}}{O_2} \rightarrow \underset{\substack{\text{Magnesium oxide}\\\text{(compound)}}}{2MgO} \quad \textit{...(at high temperature)}$$

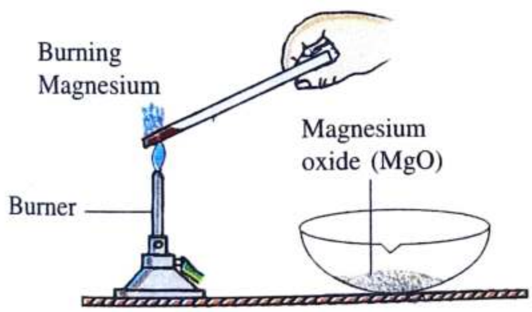
- Reaction between magnesium and oxygen is a **direct combination** reaction between two elements.
- Magnesium oxide has basic nature as it interacts with water to give magnesium hydroxide.

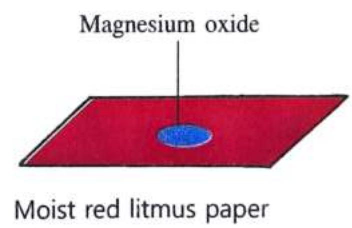
$$\underset{\text{Magnesium oxide}}{MgO} + \underset{\text{Water}}{H_2O} \rightarrow \underset{\text{Magnesium hydroxide}}{Mg(OH)_2} \quad \textit{...(partially soluble)}$$

- Magnesium hydroxide turns red litmus solution to blue. Therefore, MgO has basic nature.

Experimental Steps

- Clean the surface of magnesium ribbon (strip of magnesium) by rubbing it with sand paper and remove the dust.
- Light a burner.
- Hold the magnesium strip carefully in a holder or between the pair of tongs.
- Bring one end of the magnesium strip in contact with the flame of the burner (it burns brilliantly).





- Collect and cool the white powder (white ash) in a china dish.
- Label it "**Magnesium oxide, MgO**".
- Bring a moist red litmus paper in contact with the white powder of magnesium oxide.
- Record the experimental observations in a tabular form.

Observation table for the reaction $2Mg + O_2 \rightarrow 2MgO$

S. No.	Experiment	Observation	Inference
1.	Rub the magnesium ribbon with sand paper.	It is silvery white.	Magnesium metal is silvery white.
2.	Bring one end of magnesium ribbon in contact with the flame of the burner.	It burns brilliantly with a dazzling white light and a white powder is formed.	Magnesium combines with oxygen of air to form MgO.
3.	Put a small portion of the white powder of magnesium oxide on a moist red litmus paper.	Red litmus paper turns blue.	Magnesium oxide has basic nature.

Conclusion

- When magnesium burns in air, it combines with the oxygen of air to form a white powder of magnesium oxide.

$$2Mg(s) + O_2(g) \rightarrow 2MgO(s)$$

- Magnesium oxide is basic in nature.

Type of Reaction

- The reaction $2Mg + O_2 \rightarrow 2MgO$ is a **direct combination** of two elements.
- It represents a **chemical change**.

Precautions

- The surface of magnesium ribbon should be cleaned properly.
- Safety glasses should be used to protect eyes from dazzling light of burning magnesium.
- Non-burning end of magnesium should be attached to a wooden stick to hold it.
- White powder of magnesium oxide should not be touched.

EXPERIMENT 3(C)

Aim

To study the chemical reaction of zinc with dilute sulphuric acid and to classify it as physical or chemical change.

Materials Required

Zinc metal, dilute sulphuric acid, a conical flask, one bore cork, a glass tube, solution of sodium hydroxide.

Basic Principles Involved

- Zinc is an active metal. It has two valence electrons.
- This metal has a tendency to lose its valence electrons and get oxidised.

  $Zn \rightarrow Zn^{2+} + 2e^-$ ...*oxidation*

- Hydrogen is less reactive than zinc. Therefore, in the presence of zinc atom, the hydrogen ion is reduced as:

  $2H^+ + 2e^- \rightarrow H_2(g)$ ...*reduction*

- Redox reaction is:

$$Zn(s) + 2H^+(aq) \rightarrow Zn^{2+}(aq) + H_2(g)$$

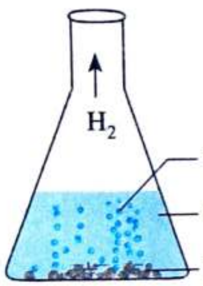
- When zinc metal is added to dilute sulphuric acid the following chemical reaction takes place:

$$\underset{\text{Zinc}}{Zn(s)} + \underset{\text{Sulphuric acid}}{H_2SO_4(aq)} \rightarrow \underset{\text{Zinc sulphate}}{ZnSO_4(aq)} + \underset{\text{Hydrogen gas}}{H_2(g)}$$

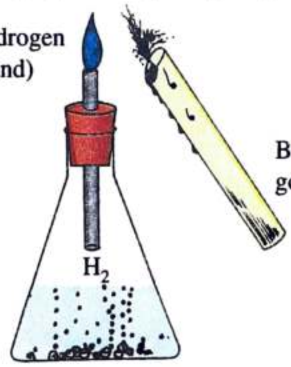
- This reaction is an example of **single displacement** of a non-metal by a metal where a gas is evolved.

Experimental Steps

- Take about 20 mL of dilute sulphuric acid in a clean conical flask.
- Take granules of zinc metal and clean them to remove dust.
- Add zinc granules to sulphuric acid taken in the conical flask.
- Label the conical flask "**Zn + dil. H_2SO_4**".
- As the reaction of zinc with sulphuric acid starts, small bubbles of hydrogen gas (H_2) are formed.
- First bring a wet red litmus paper and then a wet blue litmus paper near the mouth of the conical flask. There is no change in the colour of both the litmus papers. Hydrogen gas is neutral.



$Zn + H_2SO_4 \rightarrow H_2 + ZnSO_4$



- Insert one bore cork in the mouth of the conical flask.
- Introduce a glass tube in the conical flask through the hole in the cork.
- Bring a burning candle near the upper end of the tube of the conical flask and record your observation (**permission of the school Principal is must for this**).
- When the reaction has stopped (or after 10 minutes of the start of the reaction) remove 2 mL of the solution from the conical flask, and put it in a test tube. Add a solution of sodium hydroxide and record your observations.
- Take 2 mL of the solution from the conical flask in a clean test tube. Pass H_2S gas and record your observations.
- Record the experimental observations in a tabular form.

Observation table for the reaction $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$

S. No.	Experiment	Observation	Inference
1.	Zn + dil. H_2SO_4	Formation of bubbles.	H_2 gas is produced when zinc reacts with dilute H_2SO_4
2.	First bring wet red litmus paper and then wet blue litmus paper near the mouth of the conical flask.	There is no change in the colour of either red or blue litmus paper.	Hydrogen gas is neither acidic nor basic. It is neutral.

S. No.	Experiment	Observation	Inference
3.	Bring a burning* candle near the upper end of the tube of the conical flask.	The flame of the candle goes off but the gas of the conical flask catches fire with a pop sound.	Hydrogen gas does not support combustion but is combustible.
4.	2 mL of solution + NaOH dropwise but in excess	A gelatinous white precipitate is formed which dissolves in excess of NaOH.	Zinc ion is present in solution.
5.	2 mL of solution + H_2S	A white precipitate of zinc sulphide is formed.	During reaction between zinc and H_2SO_4, Zn^{2+} ions pass into solution.

* Permission of the school Principal is must to perform this test.

Conclusion

- The reaction of zinc with dilute sulphuric acid produces hydrogen gas.

$$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$$

- Zinc metal is more reactive than hydrogen.

Type of Reaction

- During reaction hydrogen ions are displaced by zinc ions. Therefore, this reaction is an example of **single displacement** of a non-metal by a metal.
- It is a **chemical change**.

Precautions

- Sulphuric acid should be handled with care.
- Zinc granules should be cleaned before adding to sulphuric acid.
- The test of hydrogen gas should be performed with the **permission of the school Principal** and only in the presence of the science teacher.

EXPERIMENT 3(D)

Aim

To study the changes when copper sulphate is heated and to identify the type of the change.

Materials Required

Sample of copper sulphate pentahydrate ($CuSO_4.5H_2O$), test tubes, stand with clamp, burner, ice, beaker, delivery tube, one bore wooden cork, dropper, blue and red litmus papers, solution of barium chloride.

Basic Principles Involved

- Copper sulphate pentahydrate is a blue crystalline solid. Its commercial name is blue vitriol. Its formula is $CuSO_4.5H_2O$. In this formula $5H_2O$ represents five molecules of hydration or five molecules of water of crystallisation.
- When copper sulphate is slowly heated, water vapour comes out and is condensed as liquid. On heating for some more time up to 110 °C the original blue colour of the salt fades and turns dirty white. This solid is copper sulphate monohydrate ($CuSO_4.H_2O$).

$$\underset{\text{Copper sulphate pentahydrate}}{CuSO_4.5H_2O(s)} \rightarrow \underset{\text{Copper sulphate monohydrate}}{CuSO_4.H_2O(s)} + \underset{\text{Water}}{4H_2O(l)}$$

- On further heating upto 150 °C the last molecule of water is also removed and anhydrous copper sulphate ($CuSO_4$) is formed which is white in colour.

$$\underset{\text{Copper sulphate monohydrate}}{CuSO_4.H_2O(s)} \rightarrow \underset{\text{Anhydrous copper sulphate}}{CuSO_4(s)} + \underset{\text{Water}}{H_2O\ (l)}$$

- On adding a few drops of water to anhydrous copper sulphate the blue colour of the salt reappears.

$$\underset{\text{Anhydrous copper sulphate}}{CuSO_4(s)} + \underset{\text{Water}}{5H_2O(l)} \rightarrow \underset{\text{Copper sulphate pentahydrate}}{CuSO_4.5H_2O(s)}$$

- When anhydrous copper sulphate is dissolved in water a blue solution is formed and heat is produced. that is, dissolution of anhydrous copper sulphate is an exothermic process.

$$\underset{\text{White solid}}{CuSO_4(s)} + \text{Water} \rightarrow \underset{\text{Blue solution}}{CuSO_4(aq)} + \text{Heat}$$

Observations when copper sulphate is heated

S. No.	Experiment	Observation	Inference
1.	Heat the given sample of copper sulphate in a dry glass test tube marked **A**.	• Water vapour comes out and condenses in test tube **B**. • The blue colour of solid in test tube **A** fades and turns white.	Blue copper sulphate loses water of crystallisation and turns anhydrous.
2.	Test the liquid in test tube **B** with blue and red litmus papers.	No change in litmus papers is observed.	Liquid of test tube **B** is neutral, it is water.
3.	To a small portion of white solid of test tube **A** add two drops of water.	White solid turns blue.	Hydrated copper sulphate is formed.
4.	Dissolve a small portion of white solid in water in test tube **C** and touch its outer surface.	A blue solution is formed and outer surface of test tube becomes warm.	Dissolution of anhydrous copper sulphate in water is exothermic.
5.	Heat the white solid of test tube **A** very strongly.	A colourless gas evolves and a black solid is left in test tube **A**.	Anhydrous copper sulphate decomposes.
6.	Test the liquid collected in test tube **B** with blue litmus paper.	Blue litmus turns red.	Dissolved gas has acidic nature, it is SO_3.
7.	Add 10 drops of liquid of test tube **B** to a solution of $BaCl_2$.	A white precipitate is formed which is insoluble in acids.	SO_3 reacts with water and forms H_2SO_4 which gives white precipitate of $BaSO_4$.
8.	Dissolve black solid of test tube **A** in sulphuric acid.	A blue solution is formed.	Black solid is CuO which is changed to $CuSO_4$.
9.	Concentrate blue solution and leave it undisturbed.	Blue solid is obtained.	$CuSO_4$ crystallises.

* Steps 5 to 9 to be demonstrated by the teacher only.

Conclusion

When copper sulphate pentahydrate is heated it undergoes decomposition in the following steps:

(*i*) $CuSO_4.5H_2O(s) \rightarrow CuSO_4.H_2O(s) + 4H_2O(l)$

Copper sulphate pentahydrate → Copper sulphate monohydrate + Water

(*ii*) $CuSO_4.H_2O(s) \rightarrow CuSO_4(s) + H_2O(l)$

Copper sulphate monohydrate → Copper sulphate anhydrous + Water (*iii*) $CuSO_4(s) \rightarrow CuO(s) + SO_3(g)$

Copper sulphate — Copper (II) oxide — Sulphur trioxide

The entire reaction of heating copper sulphate pentahydrate may be represented as follows

$$CuSO_4.5H_2O(s) \rightarrow 5H_2O(l) + SO_3(g) + CuO(s)$$

Copper sulphate pentahydrate — Water — Sulphur trioxide — Copper (II) oxide

Type of Change

- Heating copper sulphate pentahydrate upto 150 °C is a **physical change**.
- Decomposition of anhydrous copper sulphate is a **chemical change**.

Precautions

- Copper sulphate is a poisonous chemical, therefore, it should be used with care and only in the supervision of the teacher.
- In the beginning of the experiment, the heating should be gentle. Copper sulphate should be heated strongly only when the blue solid turns white.
- Delivery tube should be removed only after letting the apparatus to cool.
- Only very small quantity of white solid should be removed from test tube A to test it with water.
- Contact with sulphur trioxide must be avoided because it combines even with atmospheric moisture and forms sulphuric acid.
- **Never attempt to test the odour of the gas coming out of the test tube A.**

Precautions to be taken while handling copper sulphate

- Contact of copper sulphate with skin can cause itching and eczema. Therefore, its contact with skin should be avoided by using rubber gloves.
- Copper sulphate has acidic nature and it can cause irritation to eye, skin and respiratory tract.
- It is poisonous and may cause nausea, vomiting, headache, burning pain in chest and abdomen.
- In case of copper sulphate poisoning, give large amount of milk or water to the patient and immediately seek medical advice.

Aim

To study the reaction between sodium sulphate and barium chloride in their aqueous solutions and to identify the type of change.

Materials Required

Solution of sodium sulphate (Na_2SO_4) in one test tube, solution of barium chloride ($BaCl_2$) in another test tube, a conical flask, glass rod.

Basic Principles Involved

- Sodium sulphate contains two sodium ions ($2Na^+$) and one sulphate ion $\left(SO_4^{2-}\right)$.

$$Na_2SO_4(aq) \rightarrow 2Na^+(aq) + SO_4^{2-}(aq)$$

- Barium chloride contains one barium ion (Ba^{2+}) and two chloride ions ($2Cl^-$).

$$BaCl_2(aq) \rightarrow Ba^{2+}(aq) + 2Cl^-(aq)$$

- On mixing the solutions of sodium sulphate and barium chloride, **double displacement** reaction takes place. In this reaction a white precipitate of barium sulphate is formed.

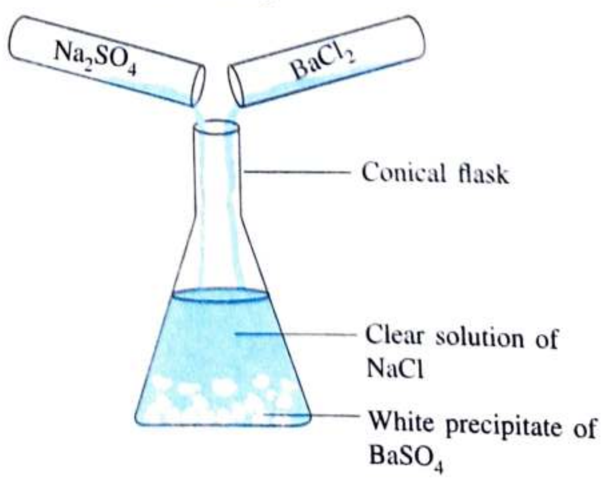
$$\underset{\text{Sodium sulphate}}{Na_2SO_4(aq)} + \underset{\text{Barium chloride}}{BaCl_2(aq)} \rightarrow \underset{\text{Barium sulphate}}{BaSO_4(s)} + \underset{\text{Sodium chloride}}{2NaCl(aq)}$$

- In the above reaction, sulphate ions are displaced by chloride ions and sodium ions are displaced by barium ions. As a result, a white precipitate of barium sulphate is formed.

Experimental Steps

- Take 10 mL solution of sodium sulphate in a test tube.
- Take 10 mL solution of barium chloride in another test tube.
- Mix the two solutions in a conical flask.
- Stir the mixture well with a glass rod.
- Leave the mixture of the conical flask undisturbed for some time.
- Record your observations.

After mixing



Observations

Before mixing the two solutions

- Solution of sodium sulphate is homogeneous and colourless.
- Solution of barium chloride is homogeneous and colourless.

After mixing the two solutions

- A white precipitate is formed.
- After sedimentation a white solid mass settles at the bottom of the conical flask.
- There is a clear liquid above the white solid in the conical flask.

Conclusion

- When a solution of sodium sulphate is mixed with a solution of barium chloride, double displacement reaction takes place.
- In this double displacement reaction a white precipitate of barium sulphate is formed and sodium chloride remains in the solution.

$$\underset{\text{Sodium sulphate}}{Na_2SO_4(aq)} + \underset{\text{Barium chloride}}{BaCl_2(aq)} \rightarrow \underset{\text{Barium sulphate}}{BaSO_4(s)} + \underset{\text{Sodium chloride}}{2NaCl(aq)}$$

Type of Chemical Reaction

- The reaction between sodium sulphate and barium chloride is a **double displacement reaction**.
- It is a **chemical change**.