CHAPTER 18 Salts

Student Learning Outcomes

After studying this chapter, students will be able to:

- Explain that salts are ionic compounds formed due to electrostatic attraction between oppositely charged ions (in which the positive ions come from bases and negative ions come from acids)
- Explain why at STP salts are solids with high melting points.
- Describe that under normal conditions, ionic compounds are usually solids with lattice structures.
- Explain why the molten and aqueous solutions of salts are good conductors of electricity by making reference to the idea of mobile ions
- Describe the general solubility rules for salts. (these are:

(a) sodium, nitrate, potassium and ammonium salts are soluble
(b) chlorides are soluble except lead and silver
(c) carbonates are insoluble except sodium, potassium and ammonium
(d) hydroxides are insoluble except sodium, potassium, ammonium and calcium (partially) .

- Describe the preparation, separation and purification of soluble salts by reactions of acids with alkali (titration), excess metal, excess insoluble base, excess insoluble carbonate.

Subjective Type Questions

Long Questions prepared in the light of new Examination Techniques
(Knowledge, Understanding, Application, Analytical & Conceptual)

Q.1: (a) What is neutralization reaction? Give example.

Ans. Neutralization Reaction:

When acids react with bases or alkalis, salts and water are formed. This reaction is called neutralization reaction.

For example: Sodium hydroxide, an alkali, neutralizes hydrochloric acid to form sodium chloride and wates.

Equation: $NaOH_{(aq)} + HCl_{(aq)} \longrightarrow NaCl_{(aq)} + H_2O_{(l)}$

(b) Define salt. How salts are formed?

Ans. Salt:

A salt is a chemical combination of positive and negative ions.

Role of Electrostatic Force of Attraction: These oppositely charged ions are then bonded together by the electrostatic force of attraction. These oppositely charged ions are then bonded together by the electrostatic force of attraction.

Strength of the Attraction:

The strength of this attraction depends on the following factors:

- Magnitude of the charges
- Distance between the ions.

Q.2: What is crystal lattice? Explain the formation of sodium chloride crystal.

Ans. Crystal Lattice:

The oppositely charged ions in a salt arrange themselves in a regular and repeating pattern to give a three dimensional network called a crystal lattice.

Properties shown by the ionic compounds:

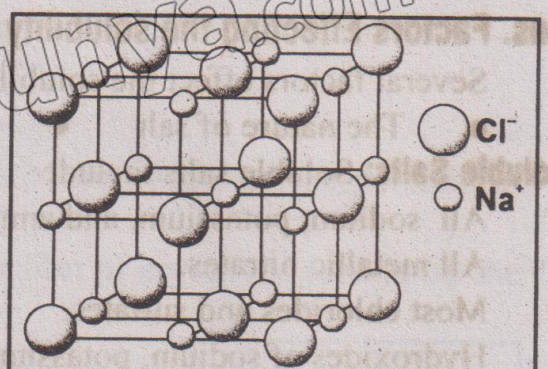
The properties shown by the ionic compounds are due to the preserve of this ordered structure (crystal lattice).

Under ordinary conditions of temperature and pressure the ionic compounds exist as crystalline solids.

Formation of sodium chloride crystal:

In sodium chloride (NaCl), each sodium ion is surrounded by six chloride ions and each chloride ion, in turn, is surrounded by six sodium ions.

- These ions are arranged in the crystal lattice having the shape of a face-centered cube.
- The bigger chloride ions are present at the corners and at the centre of each face of the cube, while the smaller sodium ions occupy the edges of the cube.



Crystal lattice of sodium chloride

Q.3: Discuss why the melting point of ionic compounds are generally very high.

Ans. Strong Electrostatic Forces of Attraction:

Since very strong electrostatic forces of attraction are present between the ions within a crystal lattice, a significant amount of energy is needed to break these forces. This is the reason that the melting points of ionic compounds are generally very high.

Explanation:

During the process of melting the attractive forces break down and let the ions move freely.

The melting points of ionic compounds depend upon the charges present on the ions and their sizes. Higher charges and small ion sizes lead to stronger attractions and hence the higher melting points.

Q.4: Why Ionic compound do not conduct electricity in solid state but in molten state and when dissolved in water they conduct electricity?

Ans. Ionic compounds in Solid state:

Ionic compounds do not conduct electricity in solid state. It is because, in the solid state ions are held together by strong forces of attraction, they are not free to move and, therefore cannot conduct electricity.

Ionic compounds in Molten state: Inoic compounds start conducting electricity in molten state. It is because when ionic compounds are heated to their melting points- their ions became free to move around and hence start conducting electricity

Ionic compounds when dissolved in water :

Inoic compounds also start conducting electricity when they are dissolved in water. It is because, when ionic compounds are dissolved in water, the forces of attraction between ions break down and the ions are again free to move independently.

Ionic compounds - As strong Electrolytes: Ionic compounds serve as a strong electrolytes because they dissociate completely into ions when dissolved in water.

18.4 Soluble and Insoluble Salts

18.5 Preparation of Soluble Salts

Q.5: Describe which salts are soluble in water and which are insoluble.

Ans. Factors Effecting the solubility of A Salt:

Several factors effect the solubility of a salt including:

- The nature of salt
- The Temperature

Soluble Salts: Soluble salts include:

- All sodium, potassium, and ammonium salts.
- All metallic nitrates.
- Most chlorides and sulfates.
- Hydroxides of sodium, potassium and ammonium.
- Calcium hydroxide is only partially soluble in water.

Insoluble salts include:

- All carbonates with the exception of carbonates of sodium, potassium and ammonium.
- Chlorides of silver and lead.
- Sulfates of barium and lead
- Beryllium and magnesium hydroxides

The following table shows the pattern for the solubility of salts in water.

Solubility of salts in water

Salts	Soluble	Insoluble
Salts of sodium, potassium and ammonium and all nitrates	All	None

Chlorides, bromides and iodides	Most soluble	Silver, Lead (II)
Sulphates	Most soluble	Barium, Lead(II), Calcium
Carbonates	Sodium, Potassium, Ammonium	Most insoluble
Hydroxides	Sodium, Potassium, Ammonium, Calcium (partially soluble)	Most insoluble

Q.6: Explain the preparation of soluble salt.

Ans. Reaction of water soluble Acid with water soluble Base

Titration Method: *This method is also called a titration method. It involves the reaction of* a water soluble acid and a water soluble base.

The acid and base are selected depending on the nature of salt which is to be prepared.

Preparation of Soluble Potassium Nitrate:

For the preparation of soluble potassium nitrate, appropriate volumes of potassium hydroxide and nitric acid are made to react together in a conical flask.

Chemical Reaction

$$KOH_{(aq)} + HNO_{3(aq)} \longrightarrow KNO_{3(aq)} + H_2O_{(l)}$$

The solution present in the conical flask now contains two things:

- The soluble salt
- The water

Transfer the solution to an evaporating dish.

There are two ways to get the water salt:

- Evaporation
- Crystallization

If the salt being prepared is stable towards heat, then evaporate the solution to dryness to get the salt

Alternatively, heat the solution gently until a thin film of crystals is formed on the surface of the solution.

Cool this solution slowly which is now saturated with salt.


Evaporating dish

Filtration and Dry:

Filter the mixture to get the pure crystals of the salt.

Dry the crystals between the folds of the filter papers.

Q.7: How will you prepare pure crystals of sodium sulphate in the laboratory?

Ans. Preparation of Pure Crystals of Sodium Sulphate:

In the laboratory, we can prepare pure crystals of sodium sulphate by performing the following activities.

(i) Add 50 cm^3 of 1 mol/dm^3 solution of sodium hydroxide in a neat conical flask with the help of a pippet.

(ii) Add a few drops of phenolphthalein indicator to get a pink colour solution.

(iii) Run 1 mol/dm^3 solution of sulphuric acid from the burette into the conical flask until the colour of solution changes from light pink to colourless.

(iv) Note down the volume of sulphuric acid used to neutralize sodium hydroxide.

$$2NaOH_{(aq)} + H_2SO_{4(aq)} \longrightarrow Na_2SO_{4(aq)} + 2H_2O$$

(v) Repeat the experiment taking the same volumes of sodium hydroxide and sulphuric acid but without using the indicator.

(vi) Transfer this neutralized solution to an evaporating dish and heat it gently until one-third of the solution is left.

(vii) Dip a glass rod into this hot solution and take it out.

(viii) If the immersed end of the glass rod turns cloudy, the solution is concentrated enough for crystals to form.

(ix) Cool down the solution for the crystallization to occur completely.

(x) Filter and wash the crystals with a little cold distilted water to remove any soluble impurities and the acid attached.

(xi) Dry the crystals within the fold of filter papers or in an oven.

Q.8: Describe the preparation of soluble salts by reaction of an acid with an insoluble base.

Ans. Preparation of Soluble salts by - Reaction of An Acid with an Insoluble Base:

This is also a neutralization reaction between the soluble acid and an insoluble base. The insoluble base may be an appropriate metal oxide, a metal carbonate or a metal hydroxide.

Selection of Acid and Insoluble Base:

- The acid and the insoluble bare are selected depending upon the salt to be prepared.
- A salt is also formed when an acid reacts with a metal.

Mixing and Stirring: This method involves

- The mixing of the selected acid with the selected base or a metal.
- Constant stirring to ensure that the acid has fully reacted with the base or the metal.

Using an Excess Amount: The insoluble base or the metal should always be added in excess to make sure that all the the acid present has reacted.

Filtering out the Left overs:

Filter the mixture to remove the excess amount of base or the metal.

Evaporation: Evaporate the filtrate to get a saturated solution.

Cooling:

Allow the solution to cool down when pure crystals of the salt will start appearing.

Drying the crystals: Filter and dry the crystals carefully.

Chemical Reactions:

$$Cu(OH)_{2(s)} + 2HCl_{(aq)} \longrightarrow CuCl_{2(aq)} + 2H_2O_{(l)}$$

$$Mg_{(s)} + H_2SO_{4(aq)} \longrightarrow MgSO_{4(aq)} + H_{2(g)}$$

$$CaCO_{3(s)} + 2HCl_{(aq)} \longrightarrow CaCl_{2(aq)} + CO_{2(g)} + H_2O_{(l)}$$

Q.9: Discuss how will you prepare pure crystals of zinc sulphate in the laboratory?

Ans. Preparation of pure crystals of Zinc sulphate:

We can prepare pure crystals of zinc sulphate in the laboratory by perforating the following activity.

Materials Pequired:

- A beaker
- An evaporating dish
- Filter paper
- Dilute sulphuric acid
- Small granules of zinc metal

Chemical equation:

$$Zn_{(s)} + H_2SO_{4(aq)} \longrightarrow ZnSO_{4(aq)} + H_{2(g)}$$

Procedure:

(i) Take about 25 cm^3 dilute sulphuric acid in a beaker and warm it gently.

(ii) Go on adding small granules of zinc metal slowly with constant stirring till the metal starts settling down at the bottom of the beaker.

(iii) Filter the solution to remove undissolved zinc metal and collect the filtrate.

(iv) Evaporate the filtrate in an evaporating dish by gentle heating to concentrate the solution without over heating or boiling.

(v) Cool down the solution slowly and allow the crystals to appear.

(vi) Once all the crystals have formed, carefully filter the mixture to get the crystals.

(vii) Allow the crystals to dry on filter paper.

18.1 Quick Check!

1. How the ions present in NaCl arrange themselves to form a crystal lattice?

Ans. In NaCl, each sodium ion is surrounded by six chloride ions and each chloride ion, in turn, is surrounded by six sodium ions.

These ions are arranged in the crystal lattice having the shape of a face- centered cube.

- The bigger chloride ions are present at the corners and at the centre of each face of the cube.
- The smaller sodium ions occupy the edges of the cube.

2. Do you expect melting point of KCl to be higher or lower than NaCl?

Ans. KCl has a lower melting point than NaCl. This is because the potassium ion (K^+) is larger than the sodium ion (Na^+), resulting in weaker electrastatic forces (lower lattice energy) and easier breaking of bonds. Smaller cations allow for stronger ionic packing, requiring more heat to melt. On the other hand larger ions result in weaker lattice structures.

18.2 Quick Check!

1. Which salts of barium and calcium are soluble in water?

Ans. Salts of Barium Soluble in water: Following salts of Barium are solube in water:

- Barium Nitrate
- Barium chloride

Salts of Calcium Soluble in water: Following salts of calcium are soluble in water:

- Calcium Nitrate
- Calcium chloride

2. How barium sulphate is prepared in the laboratory?

Ans. In the laboratory, barium sulphate is prepared using a process called precipitation.

Method:

(i) Mix two soluble salt solution together one containing barium ions (Live Barium chloride) and one containing sulfate ions (like sadium sulfate)

Reaction: $BaCl_{2(aq)} + Na_2SO_{4(aq)} \longrightarrow BaSO_4 + NaCl$

(ii) The barium sulfate forms as a solid white precipitate because it is insoluble in water.

(iii) Filter the mixture to collect the solid crystals.

INTERESTING INFORMATION

- Common salt was a valuable commodity in the past. It was even used as Currency
- Copper sulphate is used as a fungicide. Other salts are used in water softening and glass manufacture.

Objective Type Questions

Additional MCQ's

Multiple Choice Questions prepared in the light of new Examination Techniques
(Knowledge, Understanding, Application, Analytical & Conceptual)

18.1 Arrangement of Ions in Salts

18.2 Melting Points of Ionic compounds

18.3 Conduction of Electricity by Ionic Compounds

1. What are the primary products formed when an acid neutralizes a base or an alkali?

(a) salt and water
(b) salt and hydrogen gas
(c) salt and a metal
(d) Salt and an oxide

2. In the reaction $NaOH_{(aq)} + HCl_{(aq)} \longrightarrow NaCl_{(aq)} + H_2O(l)$, What does NaCl represent?

(a) Hydrochloric acid
(b) Sodium hydroxide
(c) sodium chloride
(d) Hydrogen oxide

3. Which force is responsible for bonding the oppositely charged ions together in a salt?

(a) Nuclear force
(b) Electrostatic force of attraction
(c) Gravitational force
(d) Magnetic force

4. What is the three dimensional network structure formed by ions in a salt called?

(a) Atomic cloud
(b) Liquid matrix
(c) Molecular chain
(d) Crystal lattice

5. **Under ordinary conditions of temperatuse and pressure, in what state do ionic compounds exist?**
(a) Liquid state (b) Crystalline solids (c) Gaseous state (d) Plasma state

6. **In a sodium chloride crystal, how many chloride ions surround each individuals sodium ion?**
(a) Six (b) Seven (c) Eight (d) Nine

7. **What is the geometric shape of the structure of NaCl lattice?**
(a) Hexagonal prism (b) Pyramid
(c) Face centered cube (d) Octa hedron

8. **Where are the smaller sodium ions located in the sodium crystal cube?**
(a) At the corners of the cube (b) At the center of each face
(c) In the edges of the cube (d) Floating outside the cube

9. **How was common salt used in the past?**
(a) As currency (b) As a fuel
(c) As a source of light (d) As source of radiation

10. **Ionic compounds typically have high melting points of _____ electrostatic forces of attraction are present between the ions.**
(a) Strong (b) Very strong (c) Weak (d) very weak

11. **The attractive forces break down and let the ions move freely during the process of:**
(a) Melting (b) Boiling (c) Evaporation (d) Condensation

12. **In which state do ionic compounds Not conduct electricity?**
(a) Dissolved in water (b) Molten state
(c) Solid state (d) None of these

13. **Ions are held together by strong forces of attractions in:**
(a) Liquid state (b) Solid state (c) Gaseous state (d) All of these

14. **Ionic compounds serve as:**
(a) Weak electrolytes (b) Bad electrolytes
(c) Good electrolytes (d) Strong electrolytes

15. **Higher charges and smaller ion size lead to stronger attractions and hence.**
(a) Higher boiling points (b) Lower melting points
(c) Lower boiling points (d) Higher melting points

16. **The forces of attraction between ions break down and the ions are again free to move independently, when ionic compounds are:**
(a) In solid state (b) In molten state (c) Dissolved in water (d) a and b both

18.4 Soluble and Insoluble Salts

18.5 Preparation of Soluble Salts

17. **In which state do ionic compounds NOT conduct electricity?**
(a) Molten State (b) Solid state
(c) Liquid state (d) Aqueous solution

18. **In which state of matter ions are held together by strong forces of attractions?**
(a) Solid state (b) Liquid state (c) Gaseous state (d) All of these

19. **What happens to the ions in an ionic compound when it is heated to its melting point?**
(a) They become fixed (b) They disappear
(c) They become free to move (d) None of these

20. **When an ionic compound dissolves in water the forces of attraction between its ions:**
(a) Become stronger (b) Break down
(c) Remain the same (d) Completely finish

21. **Ionic compounds serve as strong electrolytes because they _____ completely into ions when dissolved in water.**
(a) Condense (b) Freeze (c) Evaporate (d) Dissociate

22. **According to the solubility rules, which of these groups of salt are always soluble in water?**
(a) All sodium, potassium, and ammonium salts.
(b) Barium and lead sulfates
(c) Silver and lead chlorides (d) All of these

23. **All carbonates are insoluble in water with the exception of carbonates of:**
(a) Sodium (b) Potassium (c) Ammonium (d) All of these

24. **Reaction of water soluble acid with water soluble base is also known as:**
(a) Filtration (b) Crystallization (c) Titration method (d) Evaporation

25. **To prepare soluble Potassium Nitrate (KNO_3), which acid and base should be used in a titration method.**
(a) Hydrochloric acid and Potassium hydroxide
(b) Sulpuric acid and potassium carbonate
(c) Nitric acid and potassium hydroxide (d) Nitric acid and sodium hydroxide.

26. **Which of the following salt is used as a fungicide?**
(a) Magnesium hydroxide (b) Potassium nitrate
(c) Sodium carbonate (d) Copper sulphate

27. **In reaction of an acid with an insoluble base, what is the step taken to remove the excess insoluble base from the mixture?**
(a) Filtration (b) Evaporation (c) Crystallization (d) Stirring

28. **Which of these salts is typically insoluble in water?**
(a) Sodium Carbonate (b) Ammonium Nitrate
(c) Lead sulpate (d) Potassium chloride

29. **Which of the following salts is only partially soluble in water?**
(a) Potassium hydroxide (b) Calcium hydroxide
(c) Ammonium hydroxide (d) Sodium hydroxide

30. **Which indicator is used to neutralize sodium hydroxide with sulphuric acid?**
(a) Methyl orange (b) Phenolphthalein

(c) Litmus (d) a and b both

31. What colour change indicates that the sodium hydroxide has been neutralized?

(a) Colourless to pink (b) Pink to colourless
(c) Blue to red (d) Red to colourless

32. Which type of insoluble base can be used be react with a soluble acid?

(a) Metal oxide (b) Metal carbonate
(c) Metal hydroxide (d) All of these

33. If a salt being prepared is stable towards heat, how should it be recovered from the solution?

(a) Filtration (b) Evaporation to dryness
(c) Cooling (d) Heating

34. How should pure salt crystals be dried once they are filtered?

(a) By heating (b) By leaving them in a beaker
(c) Between the folds of filter paper (d) None of these.

Answers

1.	(a)	2.	(c)	3.	(b)	4.	(d)	5.	(b)	6.	(a)	7.	(c)
8.	(c)	9.	(a)	10.	(b)	11.	(a)	12.	(c)	13.	(b)	14.	(d)
15.	(d)	16.	(c)	17.	(b)	18.	(a)	19.	(c)	20.	(b)	21.	(d)
22.	(a)	23.	(d)	24.	(c)	25.	(c)	26.	(d)	27.	(a)	28.	(c)
29.	(b)	30.	(b)	31.	(b)	32.	(d)	33.	(b)	34.	(c)		

Additional Short Questions

Short Answer Questions prepared in the light of new Examination Techniques
(Knowledge, Understanding, Application, Analytical & Conceptual)

18.1 Arrangement of Ions in Salts

18.2 Melting Points of Ionic compounds

18.3 Conduction of Electricity by Ionic compoumds

1. What is a neutralization reaction?

Ans. When acids neutralize bases or alkalis, salts and water are formed. This reaction is called neutralization.

2. Write the balanced chemical equation for the neutralization reaction.

Ans. $NaOH_{(aq)} + HCl_{(aq)} \longrightarrow NaCl_{(aq)} + H_2O_{(l)}$

3. Define the term salt.

Ans. Salt: A salt is a chemical combination of positive and negative ions.

4. What is formed when an acid neutralizes a base or an alkali?

Ans. Salt and water are formed when an acid neutralizes a base or an alkali

5. What force bonds the ions in a salt?

Ans. Electrostatic force of attraction bonds positive and negative ions in a salt.

6. What two factors determine the strength of attraction in a salt?

Ans. The strength of attraction in a salt depends on the following two factors:

- Magnitude of the charges
- Distance between the ions

7. What is the regular, repeating three-dimensional network of ions called?

Ans. The regular, repeating three dimensional network of ions is called a crystal lattice.

8. In what state do ionic compounds exist under ordinary conditions of temperature and pressure?

Ans. Under ordinary conditions of temperature and pressure the ionic compounds exist as crystalline solids.

9. What is the specific shape of the sodium chloride (NaCl) lattice?

Ans. The specific shape of the sodium chloride (NaCl) lattice is a face - centered cube.

10. How many chloride ions surround each sodium ion?

Ans. Six chloride ions surround each sodium ion.

11. Which ion is larger sodium or choride?

Ans. Chloride (Cl^-) ion is larger.

12. Where are the chloride ions located in the face centered cube of sodium chloride?

Ans. In the face - centered cube of sodium chloride, the bigger chloride ions are present at the corners and at the centre of each face of the cube.

13. Where are the sodium ions located in the face- centered cube of sodium chloride?

Ans. In the face - centered cube of sodium chloride, the smaller sodium ions occupy the edges of the cube.

14. How was the salt used as a commodity in the past?

Ans. Common salt was a valuable commodity in the past. It was used as currency.

15. Why do ionic compounds generally have very high melting points?

Ans. Ionic compounds generally have very high melting points because very strong electrstatic forces of attraction are present between the ions writhin a crytal lattice.

16. Why do ionic compounds need a significant amount of energy?

Ans. Since very strong electrostatic forces of attraction are present between the ions within a crystal lattice, a significant amount of energy is needed to break these forces.

17. What does happen to the ions during the process of melting?

Ans. During the process of melting, the electrostatic forces of attraction between the ions break down and let the ions move freely.

18. Upon which two factors do the strength of the melting points in ionic compounds depend?

Ans. The melting points of ionic compounds depend upon the two factors.

- The charges present on the ions
- The sizes of the ions

19. How do ionic charges and size affect the melting points?

Ans. Higher charges and smaller ion sizes lead to stronger attractions and hence the higher melting points.

20. Why do ionic compounds not conduct electricity in the solid state?

Ans. Ionic compounds do not conduct electricity in the solid state. It is because, in the solid state ions are held together by strong forces of attraction, they are not free to move and, therefore cannot conduct electricity.

21. Under what conditions do ionic compounds conduct electricity?

Ans. Ionic compounds conduct electricity in two states.

- In molten state
- When they are dissolved in water

22. Why do ionic compunds start conducting electricity in molten state?

Ans. Ionic compounds start conducting electricity in molten state. It is because, when ionic compounds are heated to their melting points.

23. Why do ionic compounds conduct electricity when they are dissolved in water?

Ans. Ionic compounds start conducting electricity when they are dissolved in water. It is because, when ionic compounds are dissolved in water, the forces of attraction between ions break down and the ions are again free to move independenly.

24. Discus why are ionic compounds considered strong dectrolytes?

Ans. Ionic compounds serve as a strong electrolytes because they dissociate completely into ions when dissolved in water.

18.4 Soluble and Insoluble salts

18.5 Preparation of soluble salts

25. Why do ionic compounds serve as strong electrolytes?

Ans. Ionic compounds serve as strong electrolyte because they dissociate completely into ions when dissolved in water.

26. Mention two factors that effect the solubility of a salt.

Ans. Nature of salt and the temperature are the two factors that effect the solubility of a salt.

27. What do soluble salts include?

Ans. Soluble salts include:

- All sodium, potassium, and ammonium salts.

- All metallic nitrates.
- Most chlorides and sulfates
- Hydroxides of sodium, potassium and ammonium
- Calcium hydroxide is only partially soluble in water.

28. What do insoluble salts include?

Ans. Insoluble salts include:

- All carbonates with the exception of carbonates of sodium, potassium and ammonium.
- Chlorides of silver and lead.
- Sulphates of barium and lead
- Beryllium and magnesium hydroxides.

29. What happens to ions when an ionic compound dissolves in water?

Ans. When ionic compounds are dissolved in water, the forces of attraction between ions break down and the ions are again free to move independently.

30. What is a common use of copper sulphate?

Ans. Copper sulphate is used as a fungicide.

31. What is the titration method?

Ans. It is a method used to prepare a salt by reaction of water soluble acid with water soluble base.

32. Which reactants are used to prepare soluble potassium nitrate?

Ans. Appropriate volumes of potassium hydroxide (KOH) and nictric acid (HNO_3) are reacted together in a conical flask.

33. Is a salt formed when an acid reacts with a metal?

Ans. Yes, a salt is formed when an acid reacts with a metal.

34. Why is the insoluble base or the metal added in excess in neutralization reaction?

Ans. The insoluble base or the metal should always be added in excess in neutratization reaction to make sure that all the acid present has reacted.

35. How do you confirm a solution is "Concentrated enough" for crystals to form?

Ans. Dip a glass rod into the neutralized solution and take it out. If the immersed end of the glass rod turns cloudy, the solution is concentrated enough for crystals to form.

36. What colour change indicates that the sodium hydroxide has been neutralized?

Ans. If a solution changes from light pink to colourless it indicates that the sodium hydroxide has been neutralized.

37. What are the products when KOH reacts with HNO_3?

Ans. KNO_3 and H_2O are the products when KOH reacts with HNO_3.

38. Which indicator is used to neutralize sodium hydroxide with sulphuric acid?

Ans. Phenolphthalein is used to neutralize sodium hydroxide with sulphuric acid

39. How is excess amount of the base or the metal remove from the mixture?

Ans. Filter the mixture to remove the excess amount of the base or the metal.

40. How should pure salt crystals be dried once they are filtered?

Ans. Once they are filtered, dry the crystals between the folds of the filter papers.

Exercise Questions (Solved)

A. Multiple Choice Questions

☆ **Choose and tick the correct answer from the given choices.**

1. Which base is not soluble in water?

(a) KOH (b) $Mg(OH)_2$ (c) NaOH (d) Na_2CO_3

2. The shape of the crystal of NaCl is:

(a) Cubic (b) Hexagonal (c) Rombic (d) Trigonal

3. Which salts are always soluble in water?

(a) Chlorides (b) Sulphates (c) Nitrates (d) Carbonates

4. Which salt will be formed when marble pieces react with dilute nitric acid?

(a) Sodium nitrate (b) Calcium nitrate

(c) Potassium nitrate (d) Magnesium nitrate

5. Water insoluble salt is:

(a) Calcium sulphate (b) Sodium sulphate

(c) Potassium sulphate (d) Magnesium sulphate

Answers

1. (b) 2. (a) 3. (c) 4. (b) 5. (a)

B. Short Answer Questions

18.1. Which factors are responsible for the strength of electrostatic forces between ions?

Ans. The strength of electrostatic forces between ions depends on the nature of the salt, which includes.

- The charge of the ions
- The size of the ions

18.2 Is lead (II) chloride soluble in water? Give comments.

Ans. Generally, most chlorides are soluble, however, lead (II) chloride is an exception. It is considered insoluble in cold water, though it can become slightly more soluble if the water is heated.

18.3 Which lead salts are insoluble in water?

Ans. Following lead salts are insoluble in water:

- Lead chloride

- Lead sulfate
- Lead carbonate

18.4 Name two insoluble carbonates.

Ans. Two insoluble carbonates are:

- Calcium carbonate
- Barium carbonate

18.5 What is a crystal lattice?

Ans. The oppositely charged ions in a salt arrange themselves in a regular and repeating pattern to give a three dimensional network called a crystal lattice.

C. Constructed Response Questions

18.1 Why are melting points of ionic salts generally very high?

Ans. Ionic salts have high melting points because they are held together by very strong electrostatic forces between the positive and negative ions.

To melt the salt, you must provide enough heat energy to break these powerful attractions throughout the entire crystal lattice. Because these bonds are so strong, a very high temperature is needed to pull the ions apart.

18.2 Why ionic salts exist in solid state?

Ans. Ionic salts exist as solids because the oppositely charged ions sodium (Na^+) and chloride(Cl^-) attract each other so strongly that they pack together in a fixed, repeating 3D pattern called a crystal lattice.

In this state, the ions are not free to move around, they are locked in place by the surrounding ions, which makes the substance a rigid solid at room temperature.

18.3 How will you prepare calcium sulphate in the laboratory?

Ans. Preparation of calcium sulphate in the Laboratory: Since calcium sulphate is an insoluble salt, it is prepared using a precipitation reaction.

Method:

(i) Mix a solution of a soluble calcium salt (like calcium chloride, $CaC\ell_2$) with a solution of a soluble sulfate (like sodium sulfate, Na_2SO_4)

(ii) The calcium ions and sulfate ions will swap partners to form solid calcium sulfate.

Reaction: Filter the mixture to collect the solid $CaSO_4$ (the precipitate), wash it with distilled water, and dry it.

18.4 Compare the melting points of $NaC\ell$ and $MgC\ell_2$.

Ans. The melting point of magnesium chloride ($MgC\ell_2$) is higher than that of Sodium chloride ($NaC\ell$)

Charge power: A magnesium ion (Mg^{2+}) has a + 2 charge, while a sodium ion (Na^+) has a +1 charge

Force of Attraction: Because the magnesium ion has a higher charge, it attracts the negative chloride ions much more strongly than the sodium ion does.

Result: Stronger attraction means more energy is required to break the bond, resulting in a higher melting point for $MgCl_2$.

18.5 How would you prepare pure crystals of copper sulfate in the laboratory?

Ans. Copper sulfate is a soluble salt, so it is prepared by reacting an acid with an insoluble base.

Method

(i) Add excess copper (II) oxide powder to warm dilute sulphuric acid.
(ii) Filter the solution to remove the extra, unreacted copper oxide.
(iii) Evaporate the filtrate (Copper sulfate solution) until it is saturated.
(iv) Allow it to cool slowly so that large, pure blue crystals of copper sulfate form.

D. Descriptive Questions

18.1 Explain the formation of sodium chloride crystal?

Ans. For answer see Q 2

18.2 Explain the methods of preparation of two soluble salts.

Ans. For answer see Q 6 and Q 8

18.3 How are the following salts prepared?

$K_2SO_4, CuC\ell_2, CaC\ell_2$

Ans. Preparation of K_2SO_4: Potassium sulfate (K_2SO_4) is a soluble salt and is typically prepared through a titration method.

Reactants: Patassium hydroxide (KOH) and sulfuric acid (K_2SO_4).

Method

(i) A known volume of KOH is titrated against K_2SO_4 using an indicator (like phenolphthalein) to find the exact neutralization point.
(ii) Once the point is found, the experiment is repeated without the indicator to get a pure solution.
(iii) The water is then evaporated to leave behind K_2SO_4 crystals

Reaction

$$2KOH_{(aq)} + 2H_2SO_{4(aq)} \longrightarrow K_2SO_{4(aq)} + 2H_2O(l)$$

Preparation of $CuCl_2$: Copper (II) chloride is a soluble salt prepared by reaction of an acid with a soluble base.

Reactants:

Copper (II) oxide and dilute hydrochloric acid (HCl).

Method:

(i) Add excess copper (II) oxide powder to a known volume of warm dilute hydrochloric acid.
(ii) Stir the mixture until no more oxide reacts, ensuring all the acid has been

neutralized.

(iii) Filter the mixture to remove the unreacted copper oxide.

(iv) Heat the filterate in an evaporating dish until the crystallization point is reached.

(v) Allow it to cool to form crystals, then filter and dry them between filter paper.

Reaction:

$$CuO_{(s)} + 2HCl_{(aq)} \longrightarrow CuCl_{2(aq)} + H_2O_{(\ell)}$$

Preparation of $CaC\ell_2$: $CaC\ell_2$ is a soluble salt prepared by reacting an acid with an insoluble carbonate.

Reactants:

Calcium carbonate ($CaCO_3$) and dilute Hydrochloric acid ($HC\ell$).

Method:

(i) Add excess calcium carbonate to dilute hydrochloric acid in a beaker.

(ii) Wait for the effervescence to stop, which indicates that all the acid has reacted.

(iii) Filter the solution to remove the left over calcium carbonate.

(iv) Evaporate the filterate to concentrate the solution.

(v) Cool the solution to allow $CaC\ell_2$ crystals to form then collect and dry them.

Reaction:

$$CaCO_{3(s)} + 2HCl_{(aq)} \longrightarrow CaCl_{2(aq)} + CO_{2(g)} + H_2O_{(\ell)}$$

18.4 Describe which salts are soluble in water and which are insoluble.

Ans. Salts that are generally soluble in water:

(i) All nitrates (NO_3^-) e.g., $NaNO_3$, KNO_3

(ii) All salts of alkali metals e.g., Na^+, Li^+ Salts

(iii) All ammonium salts (NH_4^+) e.g. NH_4Cl.

Salts that are generally insoluble in water:

(i) Most carbonates (CO_3^-) e.g., $CaCO_3$, $MgCO_3$

(ii) Most hydroxides (OH^-) e.g., $Al(OH)_3$, $Pb(OH)_2$

(iii) Most phosphates (PO_4^{3-}) e.g., $Ca_3(PO_4)_2$, $Mg_3(PO_4)_2$