

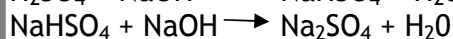
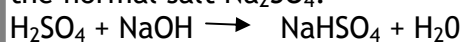
10th - Acid Bases & Salts II



Salts: A salt is a compound formed by the reaction of an acid with a base in which the hydrogen of the acid is replaced by the metal. **Type of Salts:** The different types of salts are: normal salt, acid salt, basic salt and double salt.

1. **Normal salt:** A salt that does not contain any replaceable hydrogen atoms or hydroxyl groups is called a normal salt. **Example:** Na_2SO_4 obtained in the reaction between H_2SO_4 and NaOH is a normal salt because it is formed by the complete replacement of both the H atoms of H_2SO_4 . Similarly, calcium sulphate (CaSO_4), sodium phosphate (Na_3PO_4) and potassium phosphate (K_3PO_4) are also normal salts.

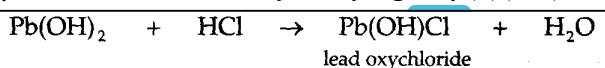
2. **Acid salt:** When an acid is not completely neutralized by a base, the salt produced will contain replaceable hydrogen atoms. Hence, it may further take part in the reaction with the base as an acid. Such a salt is called an acid salt. For example, the salt NaHSO_4 produced in the reaction between NaOH and H_2SO_4 is an acid salt because it is capable of further reaction with the base NaOH to produce the normal salt Na_2SO_4 .



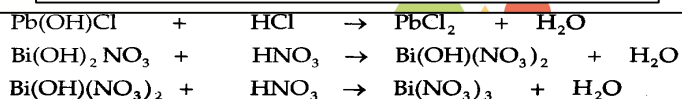
Thus, an acid salt may be defined as follows: A salt that contains replaceable hydrogen atoms is called an acid salt. Examples: NaHSO_4 , NaH_2PO_4 and Na_2HPO_4 are examples of acid salts.

2. **Basic salt:** When a base reacts with lesser amount of acid than, is necessary for complete neutralization, the salt produced contain hydroxyl group(s)(OH) also. Such a salt is called a basic salt.

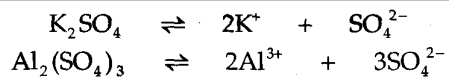
Example: Pb(OH)Cl . These salts



are called basic salts, because they can further react with the acids to form H_2O and the corresponding normal salts. Thus, a basic salt is formed when a base reacts with a lesser amount of an acid than is necessary for the formation of a normal salt.

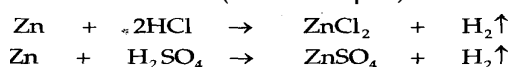


4. **Double salt:** In a double salt, there are two different negative ions and/or positive ions. For example, the mineral dolomite, $\text{CaCO}_3 \cdot \text{MgCO}_3$, contains both Ca^{2+} and Mg^{2+} ions. Hence, it is a double salt. Potash alum: $\text{K}_2\text{SO}_4 \cdot \text{Al}_2(\text{SO}_4)_3 \cdot 24\text{H}_2\text{O}$, also is a double salt. Double salts exist only in the solid state. When dissolved in water, they break up into a mixture of two separate salts. For example, when potash alum is dissolved in water, it breaks up as follows.

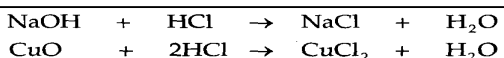


Preparation of Salts:

1. By the reaction between metal and acid: Certain metals (for example, Zn and Mg) react with HCl or H_2SO_4 to form salt and water.



2. By the reaction between an acid and a base: All acid–base reactions (neutralization reactions) produce salts.



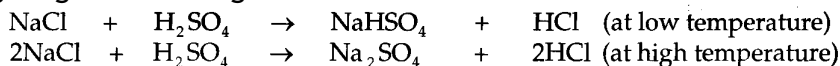
General Properties of Salts:

1. **Reaction with an acid:** When a salt reacts with an acid, another salt and acid are formed. For example, when sodium chloride is heated with sulphuric acid, sodium hydrogensulphate (at low

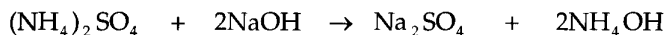
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temperature) and then sodium sulphate (at high temperature) are produced and hydrogen chloride gas is evolved.

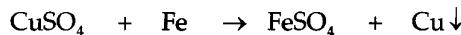


2. Reaction with a base: A salt reacts with a base to produce another salt and base.



3. Reaction with a metal:

Sometimes, a salt solution may react with a metal. For example, when an iron nail is dipped into an aqueous solution of copper sulphate, copper gets deposited on the surface of the nail and the ferrous sulphate formed remains in the solution.

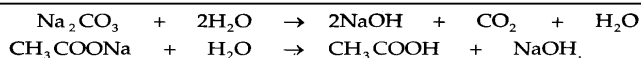


This reaction shows that iron is more reactive than copper. Thus, a more reactive metal can displace a less reactive metal from a solution of its salt.

4. Behaviour of salts towards water: When a salt is dissolved in water, the solution may be neutral, acidic or alkaline. This depends upon the nature of the salt used.

- A normal salt derived from a strong acid and a strong base gives a neutral solution. For example, the aqueous solutions of NaCl and K₂SO₄ are neutral to litmus.

- A normal salt derived from a weak acid and a strong base gives an alkaline solution. For example, the aqueous solutions of both sodium carbonate Na₂CO₃ and sodium acetate (CH₃COONa) are alkaline.



- A salt derived from a strong acid and a weak base gives an acidic solution. For example, both aluminium chloride (AlCl₃) and ammonium chloride (NH₄Cl) make acidic aqueous solutions.

- Solutions of acidic salts are acidic to litmus, i.e., these solutions turn blue litmus paper red. For example, a solution of sodium hydrogensulphate (NaHSO₄) turns blue litmus paper red. Sodium hydrogencarbonate (NaHCO₃) solution, however, is slightly alkaline.

Salts	Uses
Sodium chloride	<ol style="list-style-type: none"> 1. An essential requirement of our food 2. In the preservation of food 3. In curing fish and meat 4. In making a freezing mixture which is used by ice cream vendors 5. In the manufacture of soaps
Sodium carbonate	<ol style="list-style-type: none"> 1. As washing soda for cleaning clothes 2. Used in the manufacture of glass, paper, textiles, caustic soda, etc. 3. In the refining of petroleum 4. In fire extinguishers
Sodium bicarbonate	<ol style="list-style-type: none"> 1. Used as baking soda 2. In fire extinguishers 3. As an antacid in medicine
Potassium nitrate	<ol style="list-style-type: none"> 1. To make gunpowder, fireworks and glass 2. As a fertilizer in agriculture
Copper sulphate	<ol style="list-style-type: none"> 1. Commonly called 'blue vitriol', used as a fungicide to kill certain germs 2. In electroplating 3. In dyeing
Potash alum	<ol style="list-style-type: none"> 1. Used to purify water; makes suspended particles in water settle down 2. As an antiseptic 3. In dyeing



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The pH Scale: If we have two acidic solutions, then which is more acidic. Similar is the case with basic solutions. This problem is solved by using a scale known as the pH scale introduced by S P Sorensen in 1909. pH of a solution indicates which solution is more acidic or more basic than the other. The acidity or basicity (alkalinity) of a solution is usually expressed in terms of a function of the H⁺ ion concentration. This function is called the pH of a solution. The pH of an aqueous solution is the negative logarithm of its H⁺ ion concentration.

That is,

$$\text{pH} = -\log [\text{H}^+]$$

$$\text{pOH} = -\log [\text{OH}^-]$$

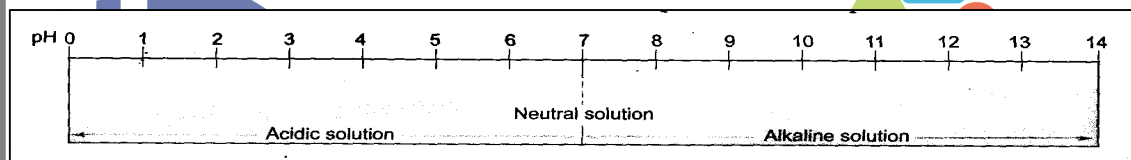
Note: [H⁺] and [OH⁻] denote the concentrations of H⁺ and OH⁻ ions respectively. The concentrations of H⁺ and OH⁻ ions in aqueous solutions are usually very small numbers and therefore difficult to work with. Since pH is the negative logarithm of [H⁺], we get positive numbers and the inconvenience of dealing with small numbers is eliminated. It should be noted here that pH is only a number, because we can take the logarithm of a number and not of a unit. Therefore, pH of a solution is a dimensionless quantity.

In a neutral solution, [H⁺] = 1.0 × 10⁻⁷ M. pH = -log(1.0 × 10⁻⁷) = 7. We can say that the pH of a neutral solution is 7.

In an acidic solution, [H⁺] > 1.0 × 10⁻⁷ M. Let us assume, [H⁺] = 1.0 × 10⁻⁵ M. pH = -log (1.0 × 10⁻⁵) = 5. Here, we find that the pH of an acidic solution is less than 7.

In an alkaline solution, [H⁺] < 1.0 × 10⁻⁷ M. Let us assume, [H⁺] = 1.0 × 10⁻⁹ M. pH = -log(1.0 × 10⁻⁹) = 9. In other words, the pH of an alkaline solution is more than 7.

The pH of different solutions at 298 K can now be expressed on the pH scale as shown below.



Rules for pH scale (at 298 K):

1. Acidic solutions have pH less than 7.
2. The lower the pH, the more acidic is the solution.
3. Neutral solutions or pure water has pH equal to 7.
4. Basic solutions have pH greater than 7.
5. The higher the pH, the more basic is the solution.

The pH values of some common solutions

How is pH measured?

The pH of a solution is generally determined with the help of a pH paper, or

universal indicator. The pH paper gives a particular colour with a solution of particular pH. The colour is compared with a chart which has different colours at different pH values.

Role of pH in everyday life:

1. In our digestive system: Hydrochloric acid produced in our stomach helps the digestion of food without causing any harm to the stomach. But when the amount of the acid goes beyond a certain limit due to indigestion, pain and irritation are

Gastric juice	1.0	Tomato juice	4.1	Pure water	7.0
Lemon juice	2.5	Acid rain	5.6	Blood	7.4
Vinegar	3.0	Urine	6.0	Limewater	11.0
Wine	3.5	Milk	6.5		



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created in the stomach. So, in order to neutralize the effect of excess acid, a mild base called antacid is usually taken. Magnesium hydroxide (milk of magnesia) is a mild base which is usually used as an antacid.

2. Acids cause tooth decay: When we eat sugary food, it gets degraded by bacteria present in the mouth and an acid is formed. When the pH becomes lower than 5.5, tooth enamel gets corroded. Saliva, which is slightly alkaline, produced in the mouth neutralizes some acid, but excess acid remains unaffected. The excess acid can be removed only by the use of toothpaste which is alkaline. Neem stick contains alkaline juice. So, the cleaning of tooth by Neem stick also helps to reduce tooth decay.

3. Acid is produced in fatigued muscle: As a result of physical exercise, stiffness and pain in the muscle starts due to the formation of lactic acid. The supply of oxygen in the muscle is reduced. This causes difficulty in the release of energy leading to increase in the rate of anaerobic metabolism. As a result, lactic acid gets accumulated in the muscles.

4. Some animals and plants contain acids: Honey-bee injects an acid through its stings which causes pain and irritation. Hence, a mild base like baking soda is applied to treat the wound. Similarly, nettle leaves, which have stinging hairs, when touched inject formic acid in our body. This causes a burning pain. **Wasp sting** leaves an alkali. Hence, a wasp sting should be washed with a mild acid such as vinegar. Note Nettle is a stinging plant. When one accidentally touches its hairs, a painful effect is produced. As a remedy, the affected area is rubbed with the dock plant. The dock plant is alkaline which neutralizes the effect of the acid.

5. The brilliance of a tarnished copper vessel can be restored by using acid: You know, lemon juice contains an acid. In order to clean a copper vessel, we rub it with the piece of a lemon. The tarnish on the vessel is caused by the formation of a layer of basic copper oxide. Since lemon juice contains citric acid, it reacts with the copper oxide to form copper citrate and is washed away. The vessel then regains its shining appearance.

6. pH of soil: Soils are generally acidic. Plants require definite pH range for their proper growth. They do not grow in alkaline soil. Many plants do not grow properly in highly acidic or highly alkaline soil. So, highly acidic soil is treated by spreading quicklime, slaked lime or calcium carbonate to lower its acidity.

pH of Salts: The aqueous solutions of all kinds of salts do not have the same pH value.

1. Salts of strong acids and strong bases: Sodium chloride (NaCl), potassium nitrate (KNO₃), sodium sulphate (Na₂SO₄), etc., are salts of this category. The aqueous solutions of these salts are neutral with pH value of 7.

2. Salts of strong acids and weak bases: Aluminium chloride (AlCl₃), copper sulphate (CuSO₄), zinc sulphate (ZnSO₄), etc., are salts of this category. The aqueous solutions of these salts are acidic with pH value less than 7.

3. Salts of weak acids and strong bases: Sodium acetate (CH₃COONa), sodium carbonate (Na₂CO₃) and sodium hydrogencarbonate (NaHCO₃) are examples of this category of salts. The aqueous solutions of these salts are basic in nature with pH value more than 7.

Some Important Salts:

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1. Sodium chloride: It is made up of sodium hydroxide and hydrochloric acid. Sodium chloride is highly soluble in water. Its solution in water is neutral as it is made up of a strong acid and a strong base.

2. Potassium nitrate: It is made from potassium hydroxide and nitric acid.

It is soluble in water. Its solution in water is neutral as it made up by the reaction between a strong acid and a strong base.

3. Aluminium chloride: It is made from aluminum hydroxide and hydrochloric acid. It is soluble in water. Its solution in water is slightly acidic as it is made up by the reaction between a strong acid and a weak base.

4. Copper sulphate: It is made from copper hydroxide and sulphuric acid. It is soluble in water. Its solution in water is slightly acidic as it is made up by the reaction between strong acid and weak base.

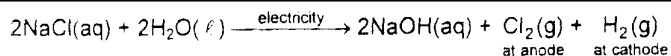
5. Sodium acetate: Sodium acetate is made from sodium hydroxide and acetic acid. Sodium acetate is soluble in water. Sodium acetate is basic in nature as it is made up by the reaction between a strong base and a weak acid.

6. Sodium carbonate: Sodium carbonate is made up from sodium hydroxide and carbonic acid. Sodium carbonate is soluble in water. Sodium carbonate is basic in nature as it is formed by the reaction between a strong base and an acid.

7. Sodium hydrogen carbonate: Sodium hydrogen carbonate is made up from sodium hydroxide and carbonic acid. Sodium hydrogen carbonate is sparingly soluble in water. It is basic in nature as it is formed by the reaction between a strong base and a weak acid.

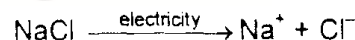
Common salt: Common salt or table salt is sodium chloride. It is used in the production of many substances like sodium hydroxide, baking soda, washing bleaching powder. A solution of salt in water is called brine.

Chlor-alkali process: When electricity is passed through an aqueous solution of sodium chloride, it decomposes to form sodium hydroxide, chlorine gas and hydrogen gas.

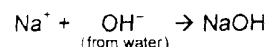


• When electricity is passed

through the solution of sodium chloride, it splits up into sodium ions and chloride ion.



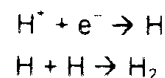
• Sodium ion combines with the hydroxyl ion of water to form sodium hydroxide.



• Chloride ions lose electron at anode and form chlorine atom.

• Two chlorine atoms combine to form a chlorine molecule. $\text{Cl}^- \rightarrow \text{Cl} + \text{e}^-$ At anode

• H of water gains electron at cathode and change into hydrogen atom.



• Two hydrogen atoms combine to form hydrogen molecule.

At cathode

• This process is known as chlor-alkali process because in this process chlorine and alkali sodium hydroxide are produced.

Uses of the by-products of the chlor-alkali process:

1. Hydrogen (H₂):

- Used for making fuels
- Used for making ammonia, which is further used for making fertilizers.
- It is used for making margarine.



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2. Chlorine (Cl₂)

- It is a very good disinfecting agent. Thus, it is used for treating drinking water and water in swimming pools.
- It is used for making poly vinyl chloride (PVC) which is a very important plastic.
- It is used for making pesticides

3. Sodium hydroxide (NaOH)

- Used for degreasing metals.
- Used for preparing soaps and detergents.
- Used for making paper.
- Used for making artificial fibres.

Common Salts in Daily Life:

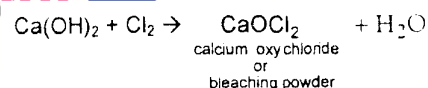
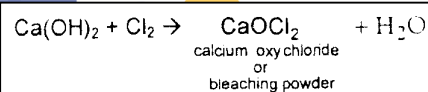
1. Common Salt (NaCl): Common salt is formed by the combination of hydrochloric acid and sodium hydroxide solution. It is the salt that we use in food. It is obtained on large scale from sea water by separating other salts from it. It may also be obtained from rock salt. Sea water contains many salts dissolved in it. Deposits of solid salt are also found in several parts of the world. These large crystals are often brown due to impurities. This is called rock salt. Beds of rock salt were formed when seas of bygone ages dried up. Rock salt is mined like coal. This salt is an important raw material for various materials of daily use, like sodium hydroxide, baking soda, washing soda, bleaching powder etc.

2. Caustic Soda [Sodium Hydroxide (NaOH)]: when electricity is passed through an aqueous solution of sodium chloride (called brine), it decomposes to form sodium hydroxide. This process is called chlor-alkali process because of the products formed, i.e. chlor (for chlorine), and alkali (for sodium hydroxide).

3. Bleaching Powder [Calcium Oxychloride (CaOCl₂)]: is produced by the action of chlorine on dry slaked lime. It is represented as CaOCl₂, though the actual composition is complex. **Uses of bleaching powder:**

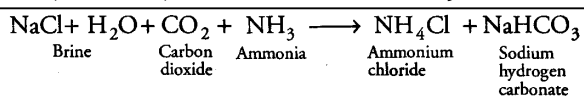
- It is used for bleaching:
 - (a) cotton and linen in the textile industry.
 - (b) wood pulp in paper factories,
 - (c) washed clothes in laundry

• It is used as an oxidizing agent in many chemical industries: the following reaction shows that bleaching powder is an oxidizing agent.

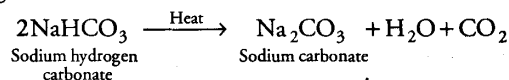


- For disinfecting drinking water to make it germ-free.

4. Baking Soda [Sodium Hydrogen Carbonate (NaHCO₃): The soda commonly used in the kitchen for making tasty crispy pakoras is baking soda. It is a mild non-corrosive base. It is the major constituent of baking powder. Sometimes, it is added for faster cooking. Chemically, it is sodium hydrogen carbonate. It is produced using sodium chloride as one of the raw material. Manufacture of baking soda is shown. Uses of baking soda:



The following reaction takes place when it is heated during cooking :



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1. When a sodium compound X which is also used in soda fire extinguisher is heated. Gives a sodium compound Y alongwith water and carbon dioxide. TY on crystallization forms a compound Z. Identify X, Y and Z.

