By- Shailendra Shukla Sir

Chapter 2 Acids, Bases and Salts

Acids and Bases

Sour and bitter tastes of food are due to acids and bases respectively present in them.

If a person is suffering from the problem of acidity due to overeating, then we suggest him to take baking soda solution as remedy. It is based on the fact that, acids and bases have an ability to nullify the effect of each other.

- **How can we decide sour and bitter substances without tasting them ?**

It is possible using acid-base indicators such as litmus, phenolphthalein, methyl orange etc.

Acids are sour in taste and change the colour of blue litmus to red.

Bases are bitter in taste and change the colour of red litmus to blue.

- **What are Acid-Base indicators ?**

Those substances which give different colours in acidic and basic mediums and indicate the presence of acid or base in a solution are called acid-base indicators. For example, litmus, phenolphthalein, methyl orange etc.

Litmus is a natural indicator. It is a purple dye which is obtained from lichen (Plant belonging to division thallophyta). When the litmus solution is neither acidic nor basic, its colour is purple.

Turmeric, red cabbage leaves, coloured petals of flowers like Hydrangea, petunia, Geranium etc. are other examples of natural indicators which indicate the presence of acid or base in a solution. These are also called acid-base indicators or simply indicators.

You have noticed that, the stain of curry on a white cloth becomes reddish-brown when soap (which is basic in nature) is scrubbed on it. It turns yellow again when cloth is washed with plenty of water.

Phenolphthalein and methyl orange are the examples of synthetic acid-base indicators.

Phenolphthalein is colourless in acidic and neutral medium but gives pink colour in basic medium.

Methyl orange is red coloured in acidic medium, but gives yellow colour in basic medium.

Q. You have been provided with three test-tubes. One of them contains distilled water and the other two contains an acidic solution and a basic solution respectively. If you are given only red litmus paper, how will you identify the content of each test tube ?

CHEMISTRYFORCOMPETITION.COM

➢ Olfactory Indicators

There are certain substances which give different odour in acidic and basic mediums. These substances are called **olfactory indicators.** Onion, Clove oil and Vanilla extract etc. are the examples of olfactory indicators. These indicators retain their characteristic smell in acidic medium, but they lose their smell in basic medium. Thus, these indicators can be used to detect, whether a solution is acidic orbasic in nature.

Olfactory indicators can be used to determine null point in acid-base titration called **olfactory titration.**

Colour of Methyl orange in Different Mediums

- In a neutral medium – Orange
- In acidic medium – Red
- In basic medium – Yellow

Colour of Phenolphthalein in Different Mediums

- In a neutral medium – Colourless
- In acidic medium – Remains colourless
- In basic medium – Pink

Activity 2.1

Collect the following samples from science laboratory-

- Hydrochloric acid (HCl)
- Sulphuric acid (H_2SO_4)
- Nitric acid (HNO_3)
- Acetic acid (CH_3COOH)
- Sodium hydroxide (NaOH)
- Calcium hydroxide [$(Ca(OH)_2$]
- Potassium hydroxide (KOH)
- Magnisium hydroxide [$(Mg(OH)_2$]
- Ammonium hydroxide (NH_4OH)

Put a drop of each of the above solutions on a watch glass and test with a drop of following indicators-

- Red litmus solution
- Blue litmus solution
- Phenolphthalein solution
- Methyl orange solution

What change in colour do you observe with each of the above indicators. Tabulate your observations in following table-

CHEMISTRYFORCOMPETITION.COM

Sample	Red litmus	Blue litmus	Phenolphthalein	Methyl orange

➢ Chemical Properties of Acids and Bases

(1) Reaction with Metals

Activity 2.3

➢ Set the apparatus shown as under-

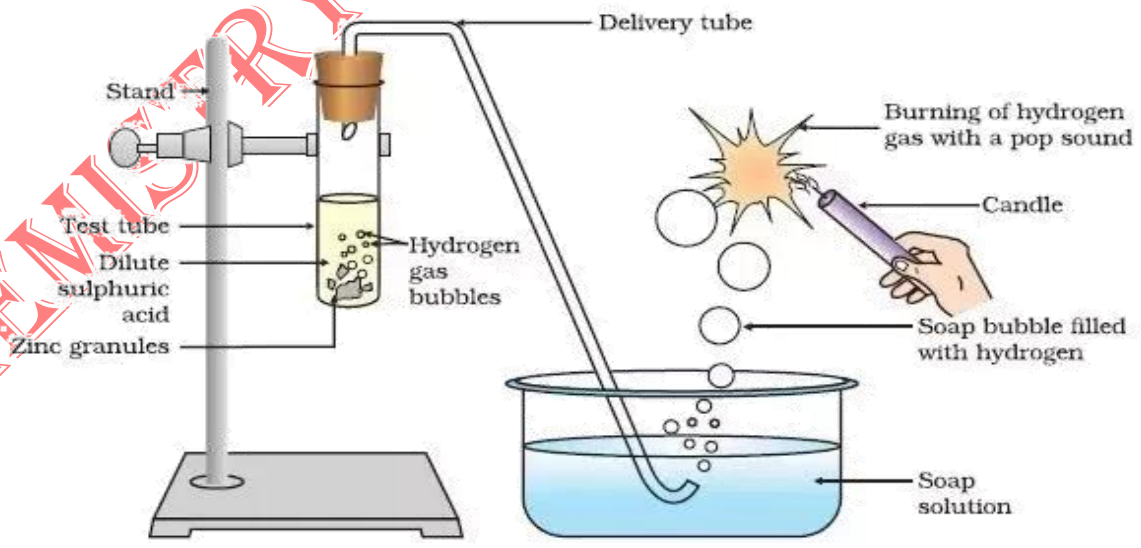


Fig. Reaction of Granulated Zinc with HCl

CHEMISTRYFOROCOMPETITION.COM

- Take about 5ml of sulphuric acid in a test tube and add a few pieces of zinc granules to it.
- What do you observe at the surface of zinc granules.
- Pass the gas being evolved through the soap solution.
- Why the bubbles formed in the soap solution ?
- Take a burning candle near a gas filled bubble. What do you observe ?
- Repeat this activity with some more acids like HCl, HNO_3 and CH_3COOH.
- Are the observations in all the cases the same or different.

Activity 2.4

- Place few pieces of granulated zinc metal in a test tube.
- Add 2 ml of sodium hydroxide solution and warm the content of test tube.
- What do you observe at the surface of zinc grannules.
- Pass the gas being evolved through the soap solution.
- Why the bubbles formed in the soap solution ?
- Take a burning candle near a gas filled bubble.
- Record your observations.

(2) Reaction of acids with metal carbonates and bicarbonates

When metal carbonates and metal hydrogencarbonate (bicarbonates) are reacted with acids, they form metal salts and release carbon dioxide gas.

Metal carbonate + Acid → Salt + Water + Carbon dioxide

Metal bicarbonate + Acid → Salt + Water + Carbon dioxide

For example,

$$Na_2CO_3(s) + 2HCl(aq) \rightarrow 2NaCl\,(aq) + H_2O(l) + CO_2(g)$$

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

$$NaHCO_3(s) + HCl(aq) \rightarrow NaCl\,(aq) + H_2O(l) + CO_2(g)$$

$$Mg(HCO_3)_2(s) + H_2SO_4(aq) \rightarrow MgSO_4(aq) + 2H_2O(l) + 2CO_2(g)$$

Here, the evolution of effervescence indicates the liberation of CO_2 gas.

On passing the carbon dioxide gas through lime water, it turns milky due to formation of white precipitate of calcium carbonate.

$$Ca(OH)_2(aq) + CO_2(g) \rightarrow CaCO_3(s) + H_2O(l)$$

Lime water — Calcium carbonate (White ppt)

When carbon dioxide gas is passed in excess, milky colour disappears due to formation of soluble calcium hydrogencarbonate.

$$CaCO_3(s) + H_2O(l) + CO_2(g) \rightarrow CaHCO_3(aq)$$

Calcium hydrogencarbonate (soluble in water)

CHEMISTRYFORCOMPETITION.COM

Activity 2.5

- Take two test tubes and label them as A and B.
- Take about 0.5g sodium carbonate (Na_2CO_3) in test tube A and 0.5g sodium hydrogencarbonate ($NaHCO_3$) in test tube B.
- Add about 2ml of dilute HCl in both the test tubes. What do you observe ?
- Pass the gas produced in each case through lime water (calcium hydroxide solution) and record your observations.

(3) Neutralisation reaction

- **How do Acids and Bases React with Each Other ?**

When an acid reacts with a base salt and water is formed. This reaction is called neutralisation reaction.

Acid + base → salt + water

For example,

$$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$$

Here, both acid and base nullify the effect of each other.

Activity 2.6

- Take about 2ml of dilute NaOH solution in a test tube and add 2 drops of phenolphthalein solution.
- What is the colour of the solution ?
- Add dilute HCl solution to the above solution drop by drop.
- Is there any colour change of the reaction mixture ?
- Why did the colour of phenolphthalein change after the addition of an acid ?
- Now add a few drops of NaOH to the above mixture.
- Does the pink colour of phenolphthalein reappear ?
- Why do you think this has happened ?

(4) Reaction of Metal oxides with Acids

In general, metal oxides are basic in nature. Hence, they react with acids to form metal salts and water.

Metal oxide + Acid → Metal Salt + Water

For example,

$$CuO(s) + 2HCl(aq) \rightarrow CuCl_2(aq) + H_2O(l)$$

Copper (II) chloride
(Blue green)

CHEMISTRYFORCOMPETITION.COM

Activity 2.7

- Take small amount of copper oxide in a beaker and add dilute hydrochloric acid while stirring.
- Note the colour of solution.
- What has happened to the copper oxide ?

(5) Reaction of Non-metal oxides with Bases

In general, non-metal oxides are acidic in nature. Hence, they react with bases to form salts and water.

Non-metal oxide + Base → Salt + Water

For example,

$CO_2(g) + Ca(OH)_2(aq) \rightarrow CaCO_3(s) + H_2O(l)$

Lime water — Calcium carbonate (White ppt)

(6) Ionization of Acids and Bases

- **What do all Acids and all Bases have in Common ?**
- All acids contain ionizable hydrogen. Hence, they ionize in their aqueous solutions to give hydrogen ions (H^+ ions).
- Let us perform an activity to investigate whether all compounds containing hydrogen are acidic.

Activity 2.8

- Take solutions of glucose, alcohol, hydrochloric acid, sulphuric acid etc.
- Fix two nails on a cork, and place the cork in a 100 ml beaker.
- Connect the nails to the two terminals of a 6 volt battery through a bulb and a switch, as shown in Figure.
- Now pour some dilute HCl in the beaker and switch on the current.
- Repeat with dilute sulphuric acid. What do you observe ?
- Repeat the experiment separately with glucose and alcohol solutions. What do you observe now ?
- Does the bulb glow in all the cases ?

CHEMISTRYFORCOMPETITION.COM

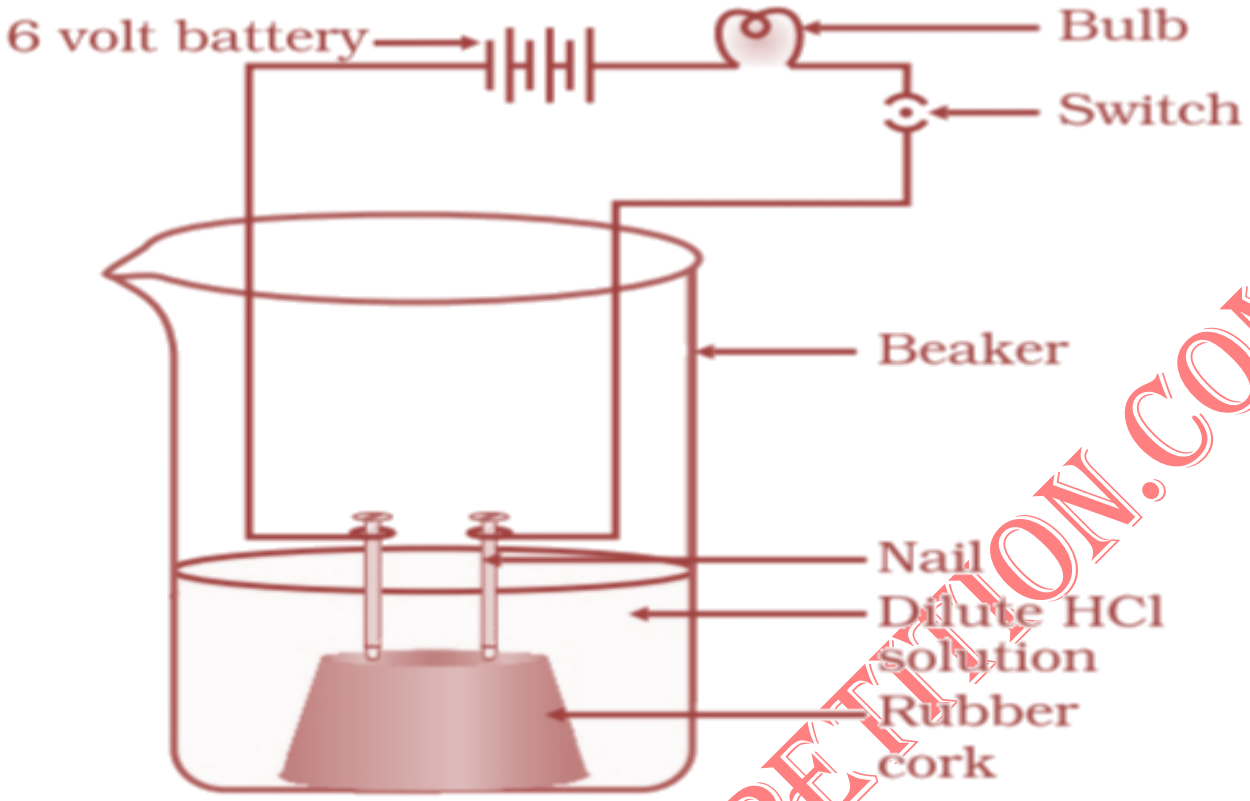


Fig. Acid solution in water conducts electricity

- Here, the bulb will start glowing in the case of acids such as hydrochloric acid, sulphuric acid, nitric acid etc. Glowing of the bulb indicates that, there is a flow of electric current through the solution.
- The flow of electric current through the acidic solution is due to flow of ions.
- Glucose and alcohol solutions do not contain ios and therefore, they do not conduct electricity. Hence, bulb does not glow in these cases.
- Acids contain H^+ ion as cation and anion such as Cl^- (in HCl), NO_3^- (in HNO_3), SO_4^{2-} (in H_2SO_4), CH_3COO^- (in CH_3COOH). Since the cation present in acids is H^+, this suggests that, all the acids produce hydrogen ions, $H^+(aq)$, in their aqueous solution, which are responsible for their acidic properties.
- Repeat the same Activity using alkalis such as sodium hydroxide, calcium hydroxide etc. What can you conclude from the results of this activity ?

CHEMISTRYFORCOMPETITION.COM

➢ What Happens to an Acid or a Base in a Water Solution ?

Do acids produce ions only in aqueous solution ? Let us test this.

Activity 2.9

- Take about l g solid NaCl in a clean and dry test tube and set up the apparatus as shown in Figure.
- Add some concentrated sulphuric acid to the test tube.
- What do you observe ? Is there a gas coming out of the delivery tube ?
- Test the gas evolved successively with dry and wet blue litmus paper.
- In which case does the litmus paper change colour ?
- On the basis of this activity, what do you infer about the acidic character of-

  (1) Dry HCl gas (2) HCl solution

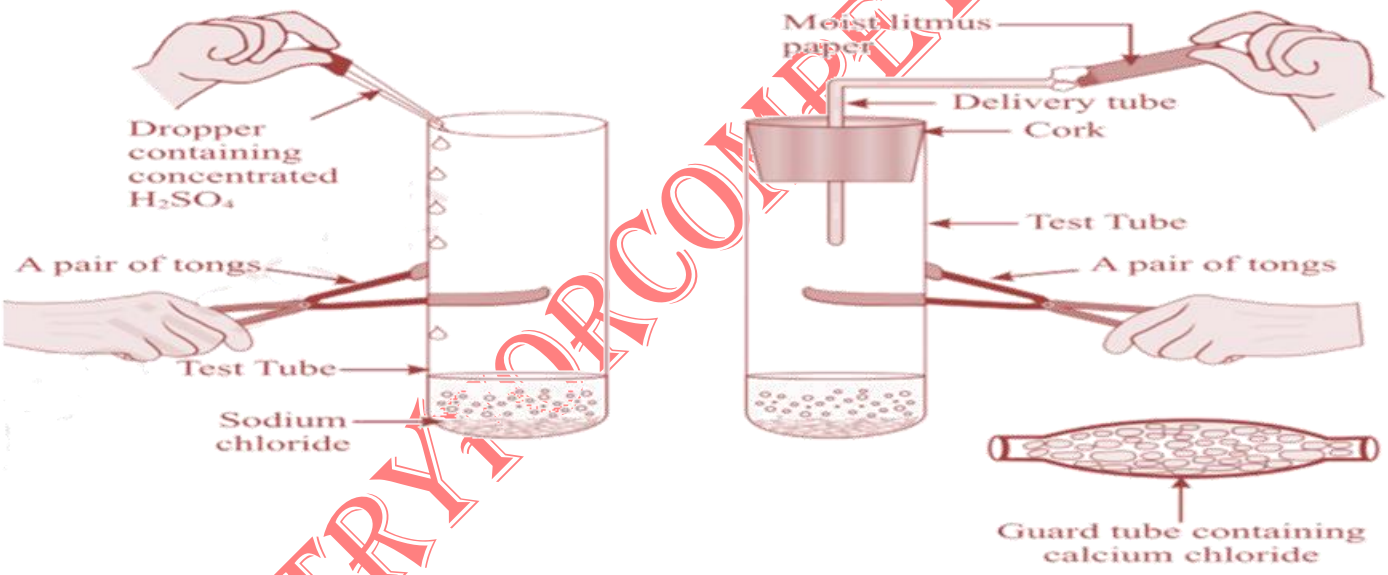


Fig.- Preparation of HCl gas

- If the climate is very humid, we have to pass the gas produced first through a guard tube (drying tube) containing calcium chloride to dry the gas before the litmus test.
- This experiment suggests that HCl ionizes to produce hydrogen ions in presence of water.

$$HCl + \mathbf{H_2O} \rightarrow \mathbf{H_3O^+} + C1^-$$

- The separation of H^+ ion from HCl molecules cannot occur in the absence of water.

CHEMISTRY FORCOMPETITION.COM

- Hydrogen ions cannot exist alone, but they exist after combining with water molecules.

$$H^+ + H_2O \rightarrow H_3O^+$$

- Thus, hydrogen ions must always be shown as $H^+(aq)$ or hydronium ion (H_3O^+).
- Thus, acids give $H^+(aq)$ or H_3O^+ ion in water.
- When a base is dissolved in water, it ionizes to give hydroxide (OH^-) ions.

$$NaOH(s) + H_2O \rightarrow Na^+(aq) + OH^-(aq)$$
$$KOH(s) + H_2O \rightarrow K^+(aq) + OH^-(aq)$$
$$Mg(OH)_2(s) + H_2O \rightarrow Mg^{2+}(aq) + 2OH^-(aq)$$

- All bases do not dissolve in water. Bases which are soluble in water are called alkalis. They are soapy to touch, bitter and corrosive. We should not taste or touch them, as they may be harmful to us.
- It is clear that, all acids generate $H^+(aq)$ and all bases generate OH^- in water. In acid-base neutralisation reactions H^+ ions of acids combine with OH^- ions of bases to form water while, their remaining part combine together to form salt. Thus, acid-base neutralisation reactions can be represented as under-

$$\text{Acid} + \text{Base} \rightarrow \text{Salt} + \text{Water}$$
$$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$$

(7) Dilution of Acids and Bases

- **What is evolved when water is mixed with an acid or a base ?**

Activity 2.10

- Take 10 ml water in a beaker.
- Add a few drops of concentrated H_2SO_4 to it and swirl the beaker slowly.
- Touch the base of the beaker.
- Is there a change in temperature?
- Is this an exothermic or endothermic process?
- Repeat this activity with sodium hydroxide pellets and record your observations.
- The process of dissolving an acid or a base in water is a highly exothermic one. Care must be taken while mixing concentrated nitric acid or sulphuric acid with water. The acid must always be

CHEMISTRYFORCOMPETITION.COM

added slowly to water with constant stirring. If water is added to a concentrated acid, the heat generated may cause the mixture to splash out and cause burns. The glass container may also break due to excessive local heating. Hence, there is warning sign on the can of concentrated sulphuric acid and on the bottle of sodium hydroxide pellets.

- Mixing an acid or base with water results in decrease in the concentration of ions (H_3O^+/OH^-) per unit volume. Such a process is called dilution and the acid or the base thus obtained is said to be diluted acid or base respectively.

Questions-

1.Why do HCl, HNO_3 etc. show acidic characters in aqueous solutions while, solutions of compounds like alcohol and glucose do not show acidic character ?

2.Why does an aqueous solution of an acid conduct electricity ?

3.Why does dry HCl gas not change the colour of the dry litmus paper ?

4.While diluting an acid, why is it recommended that the acid should be added to water and not water to the acid ?

5.How is the concentration of hydronium ions (H_3O^+) affected when a solution of an acid is diluted ?

- How is the concentration of hydroxide ions (OH^-) affected when the excess base is dissolved in a solution of sodium hydroxide ?

(8) Strength of Acids and Bases

➢ How Strong are Acid or Base Solutions ?

Acidic and basic strength of aqueous solutions depends upon the concentration of H_3O^+ and OH^- ions present in the solutions. It can be determined using a universal indicator, which is a mixture of several indicators. The universal indicator shows different colours at different concentrations of hydrogen ions in a solution.

A scale called pH scale has been developed for measuring hydrogen ion concentration in a solution. The alphabet 'p' in pH stands for '*potenz*' in German, meaning power. On pH scale we measure pH generally from 0 (very acidic) to 14 (very alkaline). pH value of aqueous solutions is simply a number which indicates the acidic or basic nature of a solution. Higher the hydronium ion concentration in a solution, lower is the pH value of the solution.

CHEMISTRYFORCOMPETITION.COM

The pH of a neutral solution is 7. Values less than 7 on the pH scale represent an acidic solution while, the value more than 7 represents a basic solution.

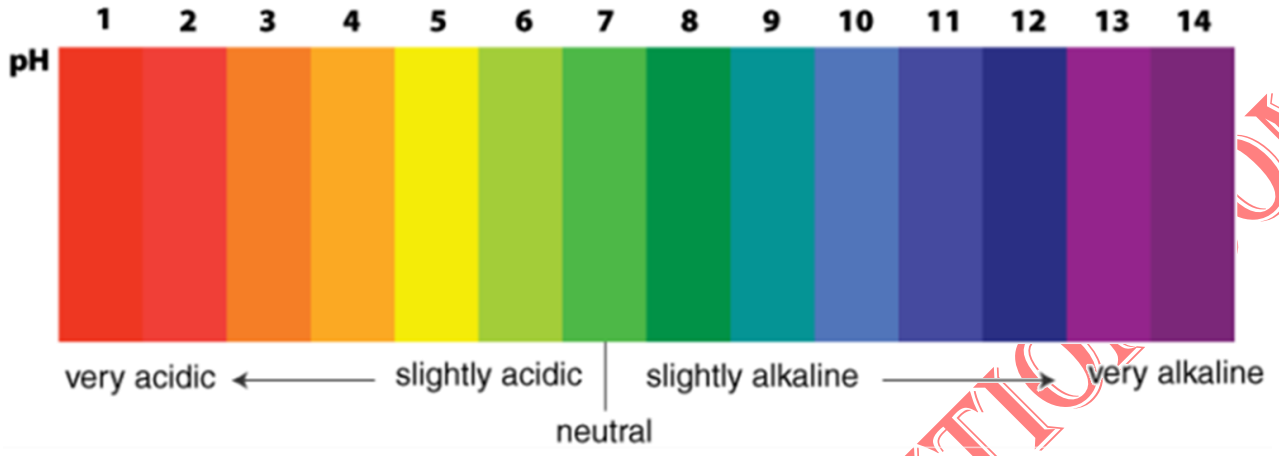


Fig.- pH Scale

As the pH value increases from 1 to 7, it represents a decrease in H_3O^+ ion concentration in the solution i.e. decrease in the acidic strength of acids.

As the pH value increases from 7 to 14, it represents an increase in OH^- ion concentration in the solution i.e. increase in the basic strength of the base.

Generally paper impregnated with the universal indicator is used for measuring pH.

The strength of acids and bases depends on the number of H^+ ions and OH^- ions produced respectively. If we take hydrochloric acid and acetic acid of the same concentration (say 1 molar) they produce different amounts of hydrogen ions. Those acids which give more H^+ ions are said to be strong acids (e.g. HCl, H_2SO_4, HNO_3 etc.), while those which give lesser H^+ ions are said to be weak acids (e.g. CH_3COOH, H_2CO_3, HCN etc.).

Similarly, If we take sodium hydroxide and ammonium hydroxide of the same concentration (say 1 molar) they produce different amounts of hydroxide ions. Those bases which give rise to more OH^- ions are said to be strong bases (e.g. NaOH, KOH, $Ba(OH)_2$ etc.) while those which give lesser OH^- ions are said to be weak bases (e.g. NH_4OH, $Mg(OH)_2$ etc.).

CHEMISTRYFORCOMPETITION.COM

(9) Importance of pH in everyday life

➢ Are plants and animals pH sensitive ?

- Plants and animals are sensitive to pH. Crucial life processes such as digestion of food, functions of enzymes and hormones etc. occur at a definite pH value.
- Our body works within the pH range of 7.0 to 7.8.
- Living organisms can survive only in a narrow range of pH.
- When pH of rain water is less than 5.6, it is called acid rain. When acid rain flows into the rivers, it lowers the pH of the river water. The survival of aquatic life in such rivers becomes difficult.

➢ What is the pH of the soil in your backyard ?

- Plants require a specific pH range for their healthy growth.
- The optimum pH of the soil for the healthy growth of plants or crops is 6.5 to 7.0.

Activity 2.12

- Put about 2 g soil in a test tube and add 5 ml water to it. Shake the contents of the test tube.
- Filter the contents and collect the filtrate in a test tube.
- Check the pH of this filtrate with the help of universal indicator paper.
- What can you conclude about the ideal soil pH for the growth of plants in your region ?

➢ What is pH in our digestive system

- Our stomach produces hydrochloric acid. It helps in the digestion of food without harming the stomach.
- The process of digestion occurs at a definite range of pH in our stomach which is 1.5-4.0.
- During indigestion the stomach produces too much acid and this causes pain and irritation.
- To get rid of this pain, people use bases called antacids. These antacids neutralise the excess acid. Magnesium hydroxide (Milk of magnesia), a mild base is often used for this purpose.

➢ pH change as the cause of tooth decay

- Tooth decay starts when the pH of the mouth is lower than 5.5.
- Tooth enamel, made up of calcium hydroxyapatite (a crystalline form of calcium phosphate) is the hardest substance in the body. It does not dissolve in water, but it is corroded when the pH in the mouth is below 5.5.

CHEMISTRYFORCOMPETITION.COM

- Bacteria present in the mouth produce acids by degradation of sugar and food particles remaining in the mouth after eating. The best way to prevent this is to clean the mouth after eating food.
- Toothpastes are generally basic, neutralise the excess acid in mouth and prevent tooth decay.
- **Self defence by animals and plants through chemical warfare**
- Acidic substances are used by animals and plants as a self-defence mechanism. For example, bee and plants like nettle secrete a highly acidic substance for self-defence. These secreted acidic substances have a specific pH.
- Have you ever been stung by a honey-bee ?
- Bee-sting leaves an acid which causes pain and irritation.
- Use of a mild base like baking soda on the stung area gives relief.
- Stinging hair of nettle leaves inject methanoic acid causing burning pain.
- **Some naturally occurring acids and their sources**

Acid	Natural Source
Acetic acid	Vinegar
Citric acid	Lemon, Sweet lemon, Orange
Tartaric acid	Tamrind
Oxalic acid	Tomato
Lactic acid	Sour Milk, Curd
Formic (methanoic) acid	Ant sting and Nettle sting

Questions-

(1) You have two solutions A and B. The pH of solution A is 6 and that of solution B is 8. Which solution has more hydrogen ion concentration ?

(2) Which of this is acidic and which one is basic ?

(3) What effect does the concentration of $H^+(aq)$ ions have on the nature of the solution ?

(4) Do basic solutions also have $H^+(aq)$ ions ? If yes, then why are these basic ?

(5) Under what soil condition do you think a farmer would treat the soil of his fields with quick lime (calcium oxide) or slaked lime (calcium hydroxide) or chalk (calcium carbonate) ?

CHEMISTRYFORCOMPETITION.COM

Salts

- In acid-base neutralisation reactions H^+ ions of acids combine with OH^- ions of bases to form water while, their remaining part combine together to form salt.

Acid + Base → Salt + Water

$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$

- Thus, a salt is a combination of an anion of an acid and a cation of a base. For example, NaCl, KCl, $NaNO_3$, $CaSO_4$ etc.
- Salts are usually prepared by the neutralization of an acid by a base.

Common salt

- Sodium Chloride (NaCl) is referred to as common salt because it is used all over the world for cooking.

Family of salts

- Salts having the same positive or negative radicals are said to belong to a family. For example, NaCl, $NaNO_3$ and Na_2SO_4 belong to the family of sodium salts. Similarly, NaCl and KCl belong to the family of chloride salts.

Activity 2.13

- Write the chemical formulae of the salts given below-
- Potassium sulphate
- Sodium sulphate
- Calcium sulphate
- Magnesium sulphate
- Copper sulphate
- Sodium chloride
- Sodium nitrate
- Sodium carbonate
- Ammonium chloride
  - Identify the acids and bases from which these salts have been obtained.
  - How many families can you identify among the salts given in this activity ?

pH of salts

  - Salts of a strong acid and a strong base are neutral with pH value of 7.
  - Salts of a strong acid and weak base are acidic with pH value less than 7,
  - Salts of a strong base and weak acid are basic with pH value more than 7.

CHEMISTRYFORCOMPETITION.COM

- The pH of a salt of a weak acid and a weak base is determined by conducting its pH test. It is close to 7 but, may either be less than 7 or more than 7.

Sodium hydroxide or Caustic Soda (NaOH)

Preparation Method (Chlor-alkali process)

When electricity is passed through an aqueous solution of sodium chloride (called brine), it decomposes to form sodium hydroxide. This process is called the chlor-alkali process because of the products formed- chlor for chlorine and alkali for sodium hydroxide.

$$2NaCl(aq) + 2H_2O(l) \rightarrow 2NaOH(aq) + Cl_2(g) + H_2(g)$$

Chlorine gas is given off at the anode, and hydrogen gas at the cathode. Sodium hydroxide solution is formed near the cathode in electrolytic tank. The three products produced in this process are all useful.

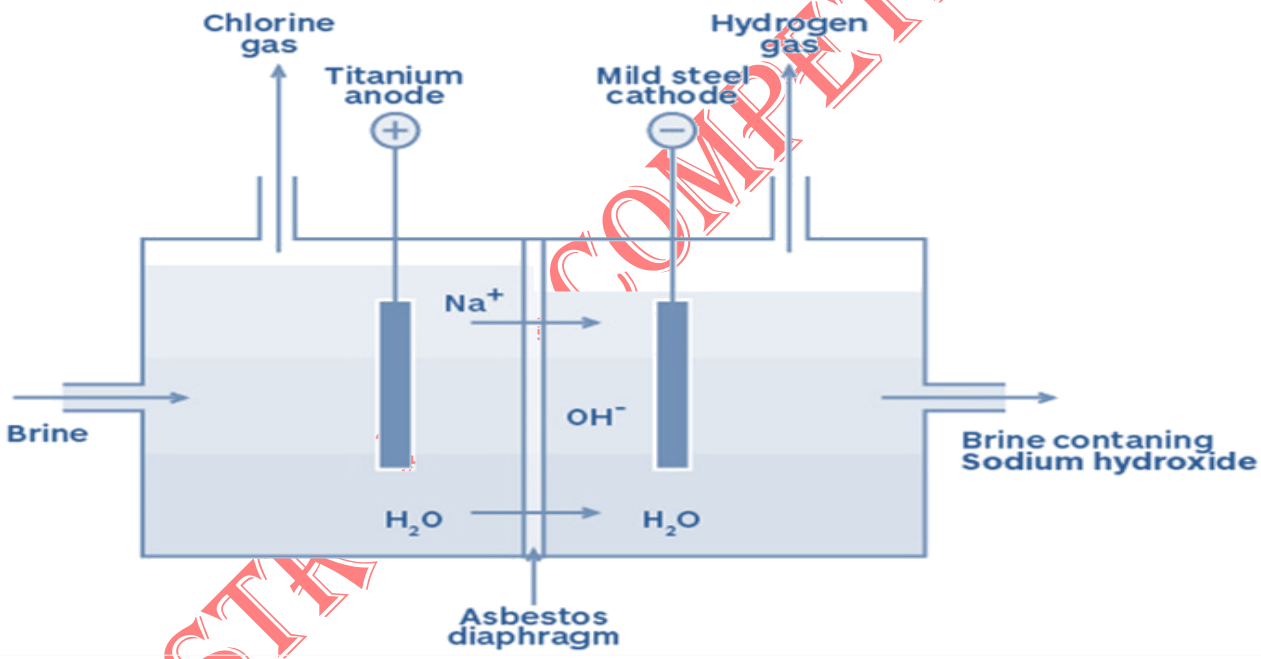


Fig.- Important products from the chlor-alkali process

Bleaching powder ($CaOCl_2$)

Bleaching powder is produced by the action of chlorine on dry slaked lime [$Ca(OH)_2$]. Bleaching powder is represented as $CaOCl_2$, though its actual composition is quite complex.

$$Ca(OH)_2 + Cl_2 \rightarrow CaOCl_2 + H_2O$$

On interaction with water, bleaching powder releases chlorine gas which is responsible for its bleaching action.

CHEMISTRY COMPETITION.COM

Uses of Bleaching Powder-

(1) For bleaching cotton and linen in the textile industry
(2) For bleaching wood pulp in paper factories
(3) For bleaching washed clothes in laundry
(4) As an oxidising agent in many chemical industries
(5) To make drinking water free from germs.

Baking soda

Chemically, sodium hydrogencarbonate or sodium bicarbonate ($NaHCO_3$) is called baking soda. It is commonly used in bakery for making breads, cakes, pastries etc. and in kitchen for making tasty crispy pakoras. Sometimes it is added for faster cooking. It is produced by carbonation of ammonical brine (sodium chloride).

$$NaCl + H_2O + CO_2 + NH_3 \rightarrow NaHCO_3 + NH_4Cl$$

Ammonical brine (Sodium hydrogencarbonate)

Sodium hydrogencarbonate is a mild non-corrosive basic salt which is used as antacid. On heating sodium hydrogencarbonate decomposes to give sodium carbonate and carbon dioxide.

$$2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$$

(Sodium hydrogencarbonate) (Sodium carbonate)

Uses of Baking soda

Sodium hydrogencarbonate has a number of uses in the household. It is used-

(1) For making baking powder, which is a mixture of baking soda (sodium hydrogencarbonate) and a mild edible acid such as tartaric acid. When baking powder is heated or mixed in water, following reaction occurs-

$$NaHCO_3 + \mathbf{H^+} \rightarrow CO_2 + \mathbf{H_2O} + \text{Sodium salt of acid}$$

(From edible acid)

Carbon dioxide produced during the reaction makes breads or cakes soft and spongy.

(2) Sodium hydrogencarbonate is also an ingredient in antacids. Being alkaline, it neutralises excess acid produced in the stomach in case of acidity and gives relief.

(3) It is also used in soda-acid fire extinguishers.

CHEMISTRYFORCOMPETITION.COM

Washing soda ($Na_2CO_3.10H_2O$)

Chemically sodium carbonate decahydrate **($Na_2CO_3.10H_2O$)** is called washing soda.

Preparation Method-

On heating sodium hydrogen carbonate (baking soda) decomposes to give sodium carbonate, which on recrystallisation gives washing soda.

$$Na_2CO_3 + 10H_2O \rightarrow Na_2CO_3.10H_2O$$

(Sodium carbonate) Sodium carbonate decahydrate

It is also a basic salt, whose aqueous solution is alkaline in nature.

Uses of washing soda

(1) In glass, soap and paper industries.

(2) In the manufacture of sodium compounds such as borax.

(3) As a domestic cleaning agent.

(4) For removing permanent hardness of water.

➢ Are the Crystals of Salts really Dry ?

Activity 2.15

- Heat a few crystals of copper sulphate in a dry boiling tube.
- What is the colour of the copper sulphate after heating ?
- Do you notice water droplets in boiling tube ? Where have these come from ?
- Add 2-3 drops of water on the sample of copper sulphate obtained after heating.
- What do you observe ? Is the blue colour of copper sulphate restored.

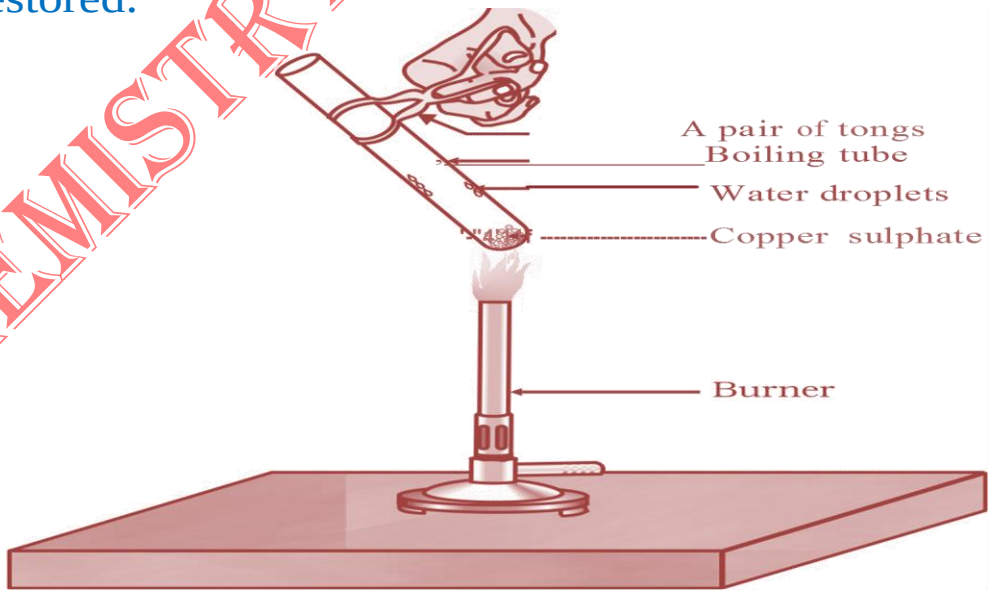


Fig.- Removal of water of crystallization

CHEMISTRYFORCOMPETITION.COM

In fact, copper sulphate crystals which appear to be dry, contain water of crystallisation. When we heat the crystals, this water is removed and the salt turns white.

If the crystals are moistened again with water, the blue colour of the crystals reappears.

Water of crystallisation is the fixed number of water molecules present in one formula unit of a salt. Five water molecules are present in one formula unit of copper sulphate. Chemical formula for hydrated copper sulphate is $CuSO_4.5H_2O$.

Other salts having water of crystallisation are washing soda ($Na_2CO_3.10H_2O$) and gypsum. ($CaSO_4.2H_2O$).

Water of crystallization does not makes the crystals wet.

Plaster of Paris

On heating gypsum at about 373 K temperature, it loses three-fourth of its water of crystallization and forms calcium sulphate hemihydrates ($CaSO_4.\frac{1}{2}H_2O$), which is called Plaster of Paris. It is the substance which is used by doctors in plaster for supporting fractured bones in the right position. Plaster of Paris is a white powder and on mixing with water, it changes to gypsum once again giving a hard solid mass.

$$CaSO_4.\frac{1}{2}H_2O + 1\frac{1}{2}H_2O \rightarrow CaSO_4.2H_2O$$

Here, only half a water molecule is shown to be attached as water of crystallisation. How can we get half a water molecule ? It is written in this form because two formula units of $CaSO_4$ share one molecule of water.

Uses of Plaster of Paris

Plaster of Paris is used for making toys, materials for decoration and for making surfaces smooth.

Questions-

(1) What is the common name of the compound $CaOCl_2$?

(2) Name the substance which on treatment with chlorine yields bleaching powder.

(3) Name the sodium compound which is used for softening hard water.

(4) What will happen if a solution of sodium hydrocarbonate is heated ? Give the equation of the reaction involved.

(5) Write an equation to show the reaction between Plaster of Paris and water.

CHEMISTRYFORCOMPETITION.COM

➢ Water of Crystallization-

Certain salts form crystals by combining with a definite proportion of water. The water present in one formula unit of a hydrated salt is called water of crystallization of respective salt. For example, hydrated copper sulphate ($CuSO_4.5H_2O$) contains 5 water molecules as the water of crystallization.

Other salts having water of crystallisation are washing soda ($Na_2CO_3.10H_2O$) and gypsum. ($CaSO_4.2H_2O$).

Water of crystallization is the part of the crystals and it does not makes the crystals wet.

Download our Mobile app "Exacademy" from App Store
Download pdf from our website-
https://chemistryforcompetition.com/
For Video Lectures Visit-
pradeep kshetrapal youtube channel

CHEMISTRYFORCOMPETITION.COM