Acids, Bases& Salts
Neutralization & Indicators

❖ Neutralization

Reaction of acid & base with each other

When a solution of acid is treated with a solution of base, salt and water are formed as the products. This reaction is called **neutralisation reaction**. In general, a neutralisation reaction can be written as

Acid + Base Salt + Water

The reaction is called neutralisation because the salt which is formed is generally neutral towards litmus. Thus, neutralisation may be defined as:

The reaction between acid and base present in aqueous solution to form salt and water.

Activity:

Aim: To study the reaction between acids and bases i.e. neutralisation reaction.

Method:

(i) Take about 2 mL of dilute NaOH solution in a test tube and add two drops of phenolphthalein solution.

(ii) Note the colour of the solution.

(iii) Add dilute HCl solution to the above solution drop by drop.

(iv) Note the change in colour of the reaction mixture.

(v) Now add a few drops of NaOH solution to the above mixture.

Observation:

On adding phenolphthalein to NaOH solution, the colour becomes pink. On adding dilute HCl solution dropwise, finally the pink colour disappears and the solution again becomes colourless. On adding NaOH pink reappears because the medium becomes basic again.

Conclusion:

Acid and base react together to form salt and water.

Acid + Base Salt + Water

The reaction is called neutralisation reaction.

Some more examples,

(i) $HNO_3(aq) + KOH\ (aq)\ \ KNO_3(aq) + H_2O\ (l)$

(ii) $HCl\ (aq) + NH_4OH\ (aq) \rightarrow NH_4Cl\ (aq) + H_2O\ (l)$

¬ **Practical Applications of Neutralisation**

(i) People particularly of old age suffer from acidity problems in the stomach which is caused mainly due to release of excessive gastric juices containing HCl. The acidity is neutralised by **antacid** tablets which contain sodium hydrogen carbonate (baking soda), magnesium hydroxide etc.

(ii) The stings of **bees** and **ants** contain formic acid. Its corrosive and poisonous effect can be neutralised by rubbing soap which contains NaOH (an alkali).

(iii) The stings of wasps contain an alkali and its poisonous effect can be neutralised by an acid like acetic acid (present in vinegar).

(iv) Farmers generally neutralise the effect of acidity in the soil caused by acid rain by dding slaked lime (calcium hydroxide) to the soil.

❖ **Indicators**

Indicator as the name suggests, indicates the nature of particular solution whether acidic, basic or neutral. Apart from this indicator also represents the change in nature of the solution from acidic to basic and vice versa. Indicators are basically coloured organic substances extracted from different plants. They can also be prepared in the laboratory.

A few common acid bases indicators are:

(i)Litmus: Litmus is a purple dye which is extracted from '*lichen*' a plant belonging to a variety Thallophyta. It can also be applied on paper in the form of strips and is available as blue and red strips. A blue litmus strip when dipped in an acid solution acquires red colour. Similarly, a red litmus strip when dipped in a base solution becomes blue. Litmus solution is a purple dye, which is extracted from lichen, a plant belonging to the division Thallophyta, and is commonly used as an indicator. When the litmus solution is neither acidic nor basic, its colour is purple. There are many other natural materials like red cabbage leaves, turmeric, coloured petals of some flowers such as Hydrangea, Petunia and Geranium, which indicate the presence of acid or base in a solution. These are called acid-base indicators or sometimes simply indicators.

(ii) Phenolphthalein: It is also an organic dye. In neutral or acidic solution, it is colourless while in the basis solution, the colour of indicator changes to pink.

(iii) Methyl orange: Methyl orange is an orange-coloured dye and keeps this colour in the neutral medium. In the acidic medium, the colour of indicator becomes red and in the basic medium, it changes to yellow. Both phenolphthalein and methyl orange are synthesized in laboratory by carrying certain chemical reactions. These are synthetic indicators. Litmus is a natural indicator extracted from plants.

¬ **Test of Distinguish Between Acids and Bases**

There are many substances which show one characteristic property (colour, odour etc.) in the acidic medium and a different property in the basic medium. **Such substances are called as acid–base indicators**. Depending upon the property of the indicator, we have the following two types of acid-base indicators.

(a) Indicators showing different colours in acidic and basic medium.

(b) Indicators giving different odours in acidic and basic medium (called olfactory indicators). Now, we shall discuss each of these one by one.

(a) Indicators show different colours in acidic and basic medium:

Activity:

From the chemistry laboratory, collect the samples of a few acids like hydrochloric acid (HCl), nitric acid (HNO_3) and bases like sodium hydroxide (NaOH) and potassium hydroxide (KOH). Put a few drops of each of them on watch glass and then add one or two drops of the main acid base indicators on them. Note the observations i.e., change in colour if any in a tabular form.

Observation:

Sample	Blue litmus solution	Red litmus solution	Phenolphthalein	Methyl orange
HCl	Changes to red	No colour change	Colourless	Changes to red
HNO_3	Changes to red	No colour change	Colourless	Changes to red
NaOH	No colour change	Changes to blue	Changes to pink	No change in colour
KOH	No colour change	Changes to blue	Changes to pink	No change in colour

Conclusion:

Acids turn blue litmus red but have no effect on red litmus. Bases turn red litmus blue but have no effect on blue litmus. Phenolphthalein is colourless in acidic medium and turns pink in basic medium. Methyl orange is yellow in basic medium and red in acidic medium.

(b) Indicators giving different odours in acidic and basic medium (Olfactory indicators):

There are some substances which give one type of odour in acidic and a different odour in the basic medium. Hence, they can be used to test whether the given substance is acidic or basic. Such indicators are called olfactory indicators. A few of these are briefly described below;

For example, onion, vanilla and clove oil etc. all of them have characteristic odours and we are all quite familiar with them. These change when some acid or base solution is brought in their contact and can be identified. However, the results in these cases are not quite satisfactory. Only some guess can be made about the nature of the substance whether acid or bases.

- **Some other Indicators :**

The acid base indicators mentioned above are very commonly used in the laboratory.

Apart from these, red cabbage juice and turmeric juice can also act as acid base indicators.

- **Red Cabbage juice :** It is purple in colour in neutral medium and turns red or pink in the acidic medium. In the basic or alkaline medium, its colour changes to green.
- **Turmeric juice :** It is yellow in colour and remains as such both in the neutral and acidic medium. In the basic medium, its colour becomes reddish or deep brown.

Importance of pH in everyday life

In general, lesser the pH of a solution, more will be its acidic strength.

Similarly, higher the pH of a solution, more will be its basic strength.

Are plants and animals pH sensitive?

Our body works within the pH range of 7.0 to 7.8. Living organisms can survive only in a narrow rang of pH change. When pH of rain water is less than 5.6, it is called acid rain. When acid rain flow into the rivers it lowers the pH of the river water. The survival of aquatic life in such river becomes difficult.

Acids in other planets

The atmosphere of venous is made up of thick white and yellowish clouds of sulphuric acid. Some flowering plants carry their own built in pH 'indicators'.

For example, the flowers of a hydrangea bush are blue in colour when grown in an cidic soil. If it is alkaline in nature, the flowers become pink.

(i) pH of the soil

The growth of plants in a particular soil is also related to its pH. Actually, different plants prefer different pH range for their growth. It is therefore, quite important to provide the soil with proper pH for their healthy growth. Soils with high, pear content or iron minerals or with rotting vegetation tend to become acidic. The soil pH can reach as low as 4. The acidic effect can be neutralised by 'liming the soil' which is carried by adding calcium hydroxide, calcium oxide or powdered chalk (calcium carbonate). These all are basic in nature and have neutralising effect. Similarly, the soil with excess of lime stone or chalk is usually alkaline. Sometimes, its pH reaches as high as 8.3 and is quite harmful for the plant growth. In order to reduce the alkaline effect, it is better to add some decaying organic matter which is acidic in nature (compost or manure) or dig in some peat.

Plants	Preferred pH range
Potatoes	4.5 — 6.0
Carrot, Sweet Potato	5.5 — 6.5
Cauliflower, garlic, tomato	5.5 — 7.5
Onion, Cabbage	6.0 — 7.5

Plants require a specific pH range for their healthy growth. To find out the pH required for the healthy growth of a plant, we should collect the soil from various places and check the pH. Also, we should note down which plants are growing in the region from which you have collected the soil.

(ii) pH in our digestive system

Our stomach produces hydrochloric acid. It helps in the digestion of food without harming the stomach. 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.

The pH of human blood varies between 7.36 to 7.42. It is maintained by the soluble hydrogen carbonates and carbonic acid present in the blood. These are known as 'buffers. In general, the role of different buffers is to help in controlling the pH of solutions. It is not possible to discuss mechanism of the buffer action at this level to the students.

(iii) pH changes 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 phosphate is the hardest substance in the body. It does not dissolve in water, but is corroded when the pH in the mouth is below 5.5. 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. Using toothpastes, which are generally basic, for cleaning the teeth, can neutralise the excess acid and prevent tooth decay.

The saliva produced in the mouth by salivary glands is of alkaline nature. It is also partially neutralises the acid present in the mouth.

(iv) Self defence by animals and plants through chemical warfare

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 methanolic acid causing burning pain.

Nettle leaves have stinging hall which cause painful stings when touched accidentally. This is due to the methanolic acid secreted by them. A traditional remedy is rubbing the area with the leaf of the dock plant, which often grows beside the nettle in the wild.

Nettle plants are herbaceous in nature and grow in the wild. These have sharp hair which contain in them methanolic acid. If they happen to touch the body by accident, their stings are very painful because methanolic acid present gets injected in the body.

These are commonly known as **stinging nettles**. You will be surprised to note that the remedy for the same is provided by the nature itself. The stung area is rubbed by the leaves of 'dock plants' which often grow beside nettle plants. Most probably, these plants inject some base or alkali which neutralises the effect of acid and has soothing effect.