Acids, Bases and Salts

Classification of Common Substances into Acids and Bases

You must have noticed that baking soda is bitter in taste and lime juice is sour in taste. **Do you know the reason for this?**

Lime juice contains chemicals that belong to the family of acids. Acids are substances that are sour to taste. Presence of these acidic chemicals makes lime juice sour. On the other hand, baking soda belongs to the family of bases. Bases are the substances that have a bitter taste.

Here, we will learn about acids, bases, and their properties.

Acids

Acids are substances having a sour taste. Orange, tamarind, raw mango etc. are sour in taste. Therefore, these substances are acidic in nature.

The given table lists some acids that are present in common substances.

Acid	Substance
Acetic acid	Vinegar
Citric acid	Lemon, orange
Tartaric acid	Tamarind, grapes
Ascorbic acid	All citrus fruits

Lactic acid	Curd

Properties of acids:

- They are sour in taste.
- They contain hydrogen ion (H^+) as a main constituent.
- They react with metals to form hydrogen gas.
- They react with carbonates and liberates CO_2 gas.
- It turns blue litmus red.

Acids are found naturally in various substances however, they have found widescale application in various fields. They are used in the production of chemical fertilizers, explosives, oil purification etc. Acids like HCl are used in the preparation of chloride salts.

Bases

Now, we know that acids are sour to taste. There is one more class of compounds that is bitter to taste and soapy to touch. These chemicals are known as **bases**. For example, soap, limewater, baking soda etc. are basic in nature.

The given table lists some bases that are present in common substances.

Base	**Substance**
$Ca(OH)_2$ (Calcium hydroxide)	Lime water
NaOH (Sodium hydroxide)	Soap
$Mg(OH)_2$ (Magnesium hydroxide)	Milk of magnesia

KOH (Potassium hydroxide)	Soap
We should not taste or touch any unknown substance. It may be harmful.	

Properties of bases:

They have a bitter taste.
They are slippery in texture.
They contain hydroxide ion (OH^-) as the main constituent.

Natural Indicators

In our daily life, we use many substances such as curd, lemon juice, vinegar etc. that are either acidic or basic in nature. However, to determine the acidic or basic nature of an unknown substance, it should not be tasted, as it may be harmful for us. **Then, how can we determine whether a substance is acidic or basic?**

To distinguish an acid from a base, special compounds are used called **indicators**.

Now, let us watch the following animation.

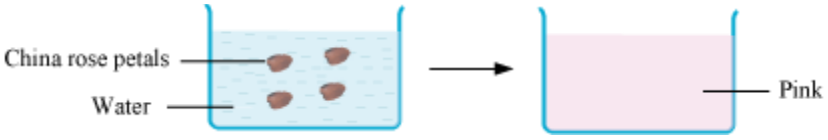
Hence, substance can be identified as acids, bases, or neutrals on the basis of the change in colour produced by red and blue litmus paper.

Solution	**Red litmus paper**	**Blue litmus paper**
Acidic	Red	Red
Basic	Blue	Blue

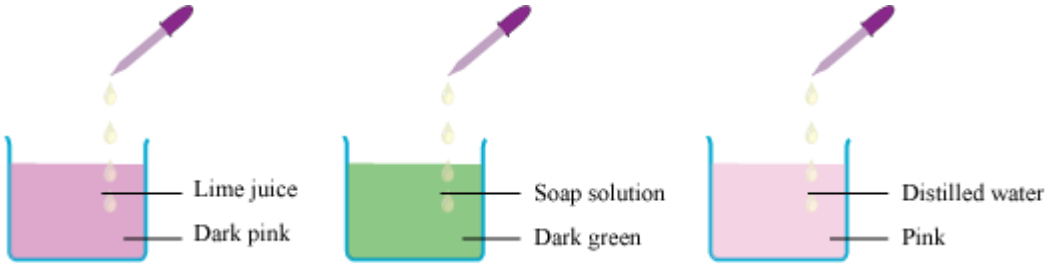
Neutral	No change in colour	No change in colour

Do you know that turmeric and China rose can also act as acid base indicators?

China rose indicator is prepared by adding petals of China rose in warm water. Then, the mixture is kept for some time until the water becomes pink in colour (as shown in the figure).



Now, if we add a few drops of this pink solution to lime juice, it turns dark pink. If we add a few drops of this pink solution to soap solution, it turns green in colour (as shown in the figure below). However, if the pink solution is added to water, no change in colour will be observed.



Thus, it can be concluded that China rose indicator gives dark pink colour with acids and green colour with bases. With neutral solutions, there is no change in colour of the China rose indictor.

Turmeric paper is another natural indicator. Turmeric paper is prepared by drying a blotting or filter paper, after applying turmeric paste on it. Turmeric paste is prepared by mixing turmeric powder and water. This strip of yellow paper is then used as an indicator strip, in the same way as litmus paper is used.

Figure - I

The colour of turmeric paper remains yellow in acidic solutions and changes to red in basic solutions. For example, if a drop of soap solution is put on a strip of turmeric paper with the help of a dropper, then that portion of the turmeric paper will turn red (as shown in figure 2). Hence, it shows that soap solution is basic in nature.

Figure 1 Figure 2

Activity:

Take hydrochloric acid, sulphuric acid, acetic acid, sodium hydroxide, lime water, ammonium hydroxide, sugar solution, common salt solution, and magnesium hydroxide. Test the nature of these substances with the help of three indicators: litmus paper, turmeric paper, and China rose solution.

The presence of acids and bases can also be tested by using phenolphthalein indicator. A drop of phenolphthalein when added to a basic solution, changes the colour of the solution to pink. On the other hand, an acidic solution has no effect of phenolphthalein and hence remains colourless.

Neutralization Reactions

We know that acids are substances that change blue litmus to red and bases are substances that change red litmus to blue. Also, acids are sour and bases are bitter to taste.

Do you know what happens when acids react with bases?

When an acid is mixed with a base, both substances neutralize each other's effect. **The reaction between an acid and a base is known as neutralization reaction**. On mixing an acid with a base, i.e., in a neutralization reaction, salt and water are obtained as products. Also, energy is evolved during the process. The general equation for the neutralization reaction is represented as:

$$\text{Acid} + \text{Base} \rightarrow \text{Salt} + \text{Water}$$

For example, when sodium hydroxide (NaOH) is treated with hydrochloric acid (HCl), then a salt, i.e., sodium chloride (NaCl) and water (H_2O) are obtained. The chemical equation for the neutralization reaction is given as:

NaOH	+	HCl	→	NaCl	+	H_2O	+ Heat
Sodium hydroxide (Base)		Hydrochloric acid (Acid)		Sodium chloride		Water	

Types of Salts:

Basic Salts: Neutralisation of a weak acid with strong base results in the formation of aqueous solutions or the salts which are basic in nature because the salt hydrolyses in water and produces OH^- .

$HCl_{(aq)} + NaOH_{(aq)} \rightarrow NaCl_{(aq)} + H_2O$ HCl (aq)+ NaOH(aq)→NaCl(aq)+ H2O

Acidic Salts: Neutralization of weak base and strong acid results in the formation of aqueous solutions or the salts which are acidic in nature because the salt hydrolyses in water and produces H_3O^+.

$HNO_{3\ (aq)} + KOH_{(aq)} \rightarrow KNO_{3\ (aq)} + H_2O_{(l)}$HNO3 (aq) + KOH(aq) → KNO3 (aq) + H2O(l)

Neutral Salts: Neutralization of strong base and strong acid results in the formation of aqueous solutions or the salts which are neutral in nature.

$NaOH_{(aq)} + HNO_{3(aq)} \rightarrow NaNO_{3(aq)} + H_2O_{(l)}$

Do You Know:

Baking soda, which is used in baking, contains sodium hydrogen carbonate. Sodium hydrogen carbonate is a weak base, which can be used for treating acidity. During baking, yoghurt or cream of tartar is usually added. This is because these substances contain acids. Sodium bicarbonate reacts with these acids and leads to the formation of carbon dioxide gas, which causes the dough to rise.

You can perform the neutralization reaction of sodium hydroxide and hydrochloric acid in your school laboratory. However, this experiment should be performed only in the presence of your science teacher.

Acids such as sulphuric acid and nitric acid also undergo neutralization reaction with sodium hydroxide base in the same way.

Some Interesting Facts:

- Salt and water are produced as products in the reaction along with the evolution of heat.
- When an acid and a base are mixed, both neutralize each other and a solution is obtained, which is neither acidic nor basic.

Can you tell what happens when we add dilute sulphuric acid to lime water? Does the reaction mixture become hot or cool?

Uses of some common salts:

- Sodium carbonate (Na_2CO_3): It is commercially available as washing soda and is used for washing purposes. It is also used in the preparation of glass and soap.
- Sodium hydrogen carbonate or sodium bicarbonate ($NaHCO_3$): It is commercially available as baking powder and is used in the baking food item like bread and bun. It is also used as an antacid which neutralizes the excessive acid in the stomach along with magnesium and aluminium hydroxide.
- Sodium chloride (NaCl): It is the common salt and it is the main ingredient of food. Common salt is used in the preservation of food like to pack fish and meat during storage.
- Ammonium chloride (NH_4Cl): It is used in dry cell as an electrolyte.
- Potassium nitrate (KNO_3): It is used in the manufacture of glass and fertilizers. It is also the main constituent of gun powder.

- Calcium carbonate ($CaCO_3$): It is largely present in marbles. It is used in the preparation of glass and cement and also used in the extraction of iron from its ore in the form of slag (calcium silicate).
- Copper sulphate ($CuSO_4$): It is also known as "blue vitriol" and "blue stone". It is used in the copper voltmeter and in electroplating. It is used in the manufacture of insecticides and in calico printing.
- Potash alum [$K_2SO_4.Al_2(SO_4)_3.24\ H_2O$]: It is a double salt and is known as potassium aluminium sulphate. It is commonly used in the purification of water and in various industries like paper industry, dying industry, leather industry etc. It stops bleeding when applied on wound.
    - Common Examples of Neutralization Reactions
    - **Do you know that our stomach contains hydrochloric acid?** Hydrochloric acid is essential for the digestion of food. Sometimes, our stomach produces excess acid, which causes pain and irritation. This condition is known as **acidity** or **indigestion**.
    - To get relief from this condition, milk of magnesia is used as an antacid. Milk of magnesia contains magnesium hydroxide, which is a mild base. It reacts with excess acid present in the stomach, and neutralizes it. This is an example of neutralization reaction, i.e., reaction taking place between an acid and a base.

When an acid is mixed with a base, both neutralize the effect of each other. **Thus, the reaction between an acid and a base is known as neutralization reaction**. Salt and water are produced in this process with the evolution of heat.

Acid + Base → Salt + Water (Heat is evolved)

- In our everyday life, we observe many examples of neutralization reactions. For example, a honeybee's sting causes pain and irritation as it contains formic acid. Similarly, when an ant bites, it injects formic acid into the skin, which causes pain and irritation. To neutralize the effect of formic acid, baking soda (sodium hydrogen carbonate) or zinc carbonate can be applied on the skin for relief.
- **Do you know that soil becomes acidic when an excess of chemical fertilizers are used?** Plants do not grow well in acidic or basic soil. Hence, to neutralize the acidity of soil, quick lime (calcium oxide) or slaked lime (calcium hydroxide) is added to soil. To neutralize excess basicity, soils are treated with organic matter, containing organic acids.
- **Do You Know:**
- Tooth enamel, which is made of calcium phosphate, is the hardest substance in the human body. It does not dissolve in water. However, it breaks down, or

disintegrates, or decays on reacting with acids. Acids are produced in the mouth due to degradation of sugar and food particles by certain bacteria.

- Toothpaste, which we use daily for cleaning our teeth, is generally basic. Hence, it can neutralize excess acid present in the mouth and prevent tooth decay.
- The wastes of many industries contain acids. This waste, when thrown directly into the water bodies, harms the aquatic life. Hence, this waste is first treated with basic chemicals to neutralize the effect of acids present in it.