CLASS – 10
CHAPTER - 2

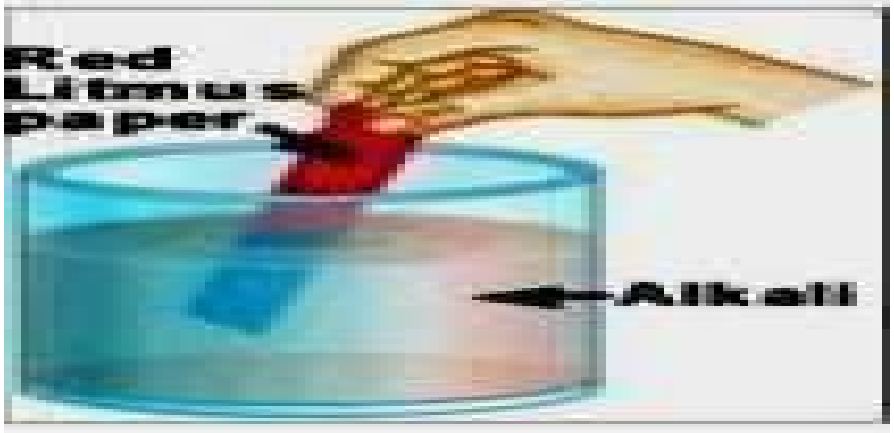
Acids, Bases and salts


HYDROCHLORIC
ACID
HCl
SODIUM
HYDROXIDE
NaOH


75
50
25


75
50
25


Blue
Litmus
paper
Acid


Red
Litmus
paper
Alkali

pH paper

Red Litmus paper

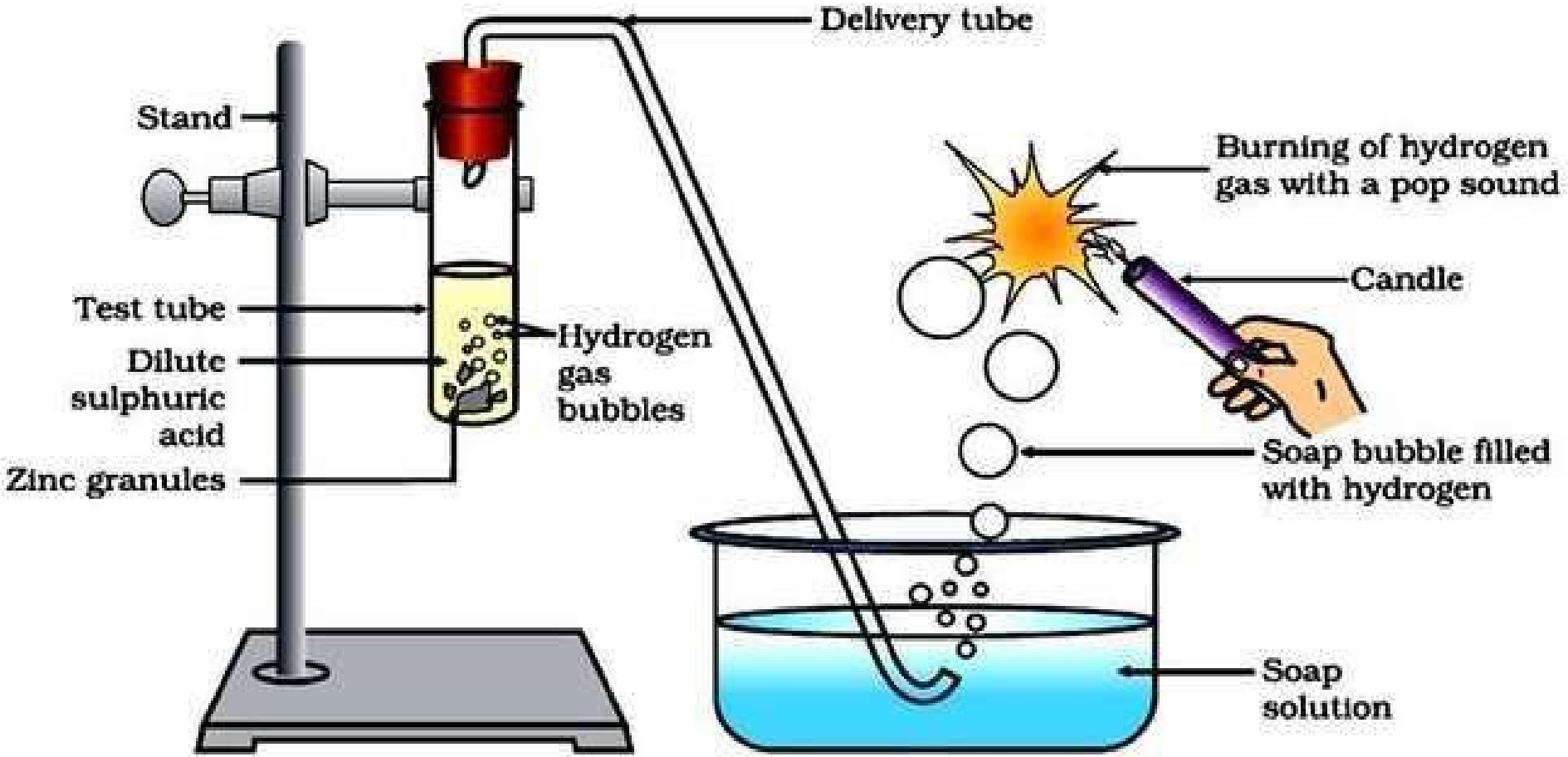
Blue Litmus paper

UNDERSTANDING THE CHEMICAL PROPERTIES OF ACIDS AND BASES

Acids and Bases in the Laboratory

The indicators tell us whether a substance is acidic or basic by change in colour. There are some substances whose odour changes in acidic or basic media. These are called olfactory indicators.

How do acids and bases react with metals?



Reaction of zinc granules with dilute sulphuric acid and testing hydrogen gas by burning

Note that the metal in the above reactions displaces hydrogen from the acids. This is seen as hydrogen gas. The metal combines with the remaining part of the acid and forms a compound called a salt. Thus, the reaction of a metal with an acid can be summarised as –

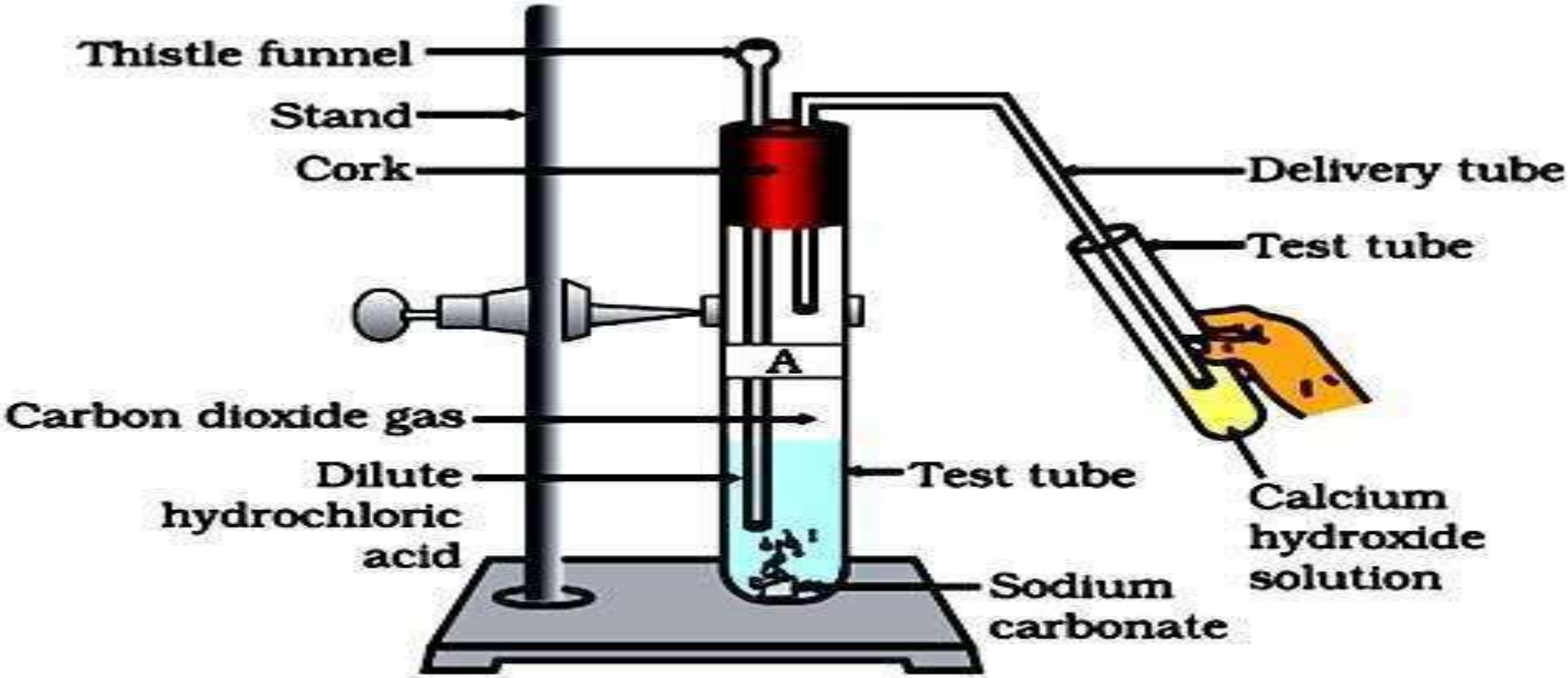
$$\text{Acid} + \text{Metal} \rightarrow \text{Salt} + \text{Hydrogen gas}$$

The reaction of metal with base can be summarised as-

$$2NaOH + Zn \rightarrow \underset{\text{(Sodium zincate)}}{Na_2ZnO_2} + H_2$$

You find again that hydrogen is formed in the reaction. However, such reactions are not possible with all metals.

➢How do metal carbonates and metal hydrogencarbonates reacts with Acids?



Passing carbon dioxide gas through calcium hydroxide solution

The reactions occurring in the above Activity are written as –

Test tube A: $Na_2CO_3(s) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(l) + CO_2(g)$

Test tube B: $NaHCO_3(s) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l) + CO_2(g)$

On passing the carbon dioxide gas evolved through lime water,

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

(Lime water) (White precipitate)

On passing excess carbon dioxide the following reaction takes place:

$$CaCO_3(s) + H_2O(l) + CO_2(g) \rightarrow Ca(HCO_3)_2(aq)$$

(Soluble in water)

Limestone, chalk and marble are different forms of calcium carbonate. All metal carbonates and hydrogen carbonates react with acids to give a corresponding salt, carbon dioxide and water. Thus, the reaction can be summarised as –

Metal carbonate/Metal hydrogencarbonate + Acid → Salt + Carbon dioxide + Water

How do acids and bases react with each other?

we have observed that the effect of a base is nullified by an acid and vice-versa. The reaction taking place is written as –

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

The reaction between an acid and a base to give a salt and water is known as a *neutralisation reaction*. In general, a neutralisation reaction

$$Base + Acid \rightarrow Salt + Water$$


HYDROCHLORIC
ACID
HCl
SODIUM
HYDROXIDE
NaOH

Reaction of Metallic Oxides with Acids

The general reaction between a metal oxide and an acid can be written as –

$$\text{metal oxide} + \text{Acid} \longrightarrow \text{salt} + \text{water}$$

Since metallic oxides react with acids to give salts and water, similar to the reaction of a base with an acid, metallic oxides are said to be basic oxides.

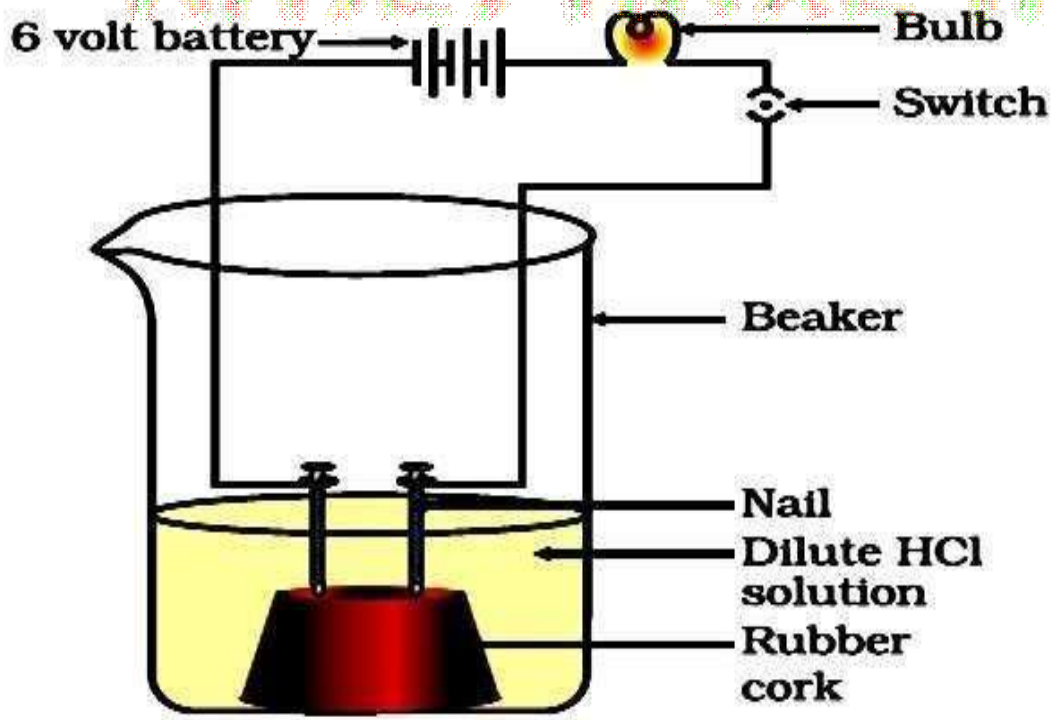
Reaction of Non Metallic Oxides with Bases

The general reaction between a Non-metal oxide and a base can be written as –

$$\text{Nonmetal oxide} + \text{Base} \longrightarrow \text{salt} + \text{water}$$

Since this is similar to the reaction between a base and an acid, we can conclude that non -metallic oxides are acidic in nature.

❖What do all acids and bases have in common?

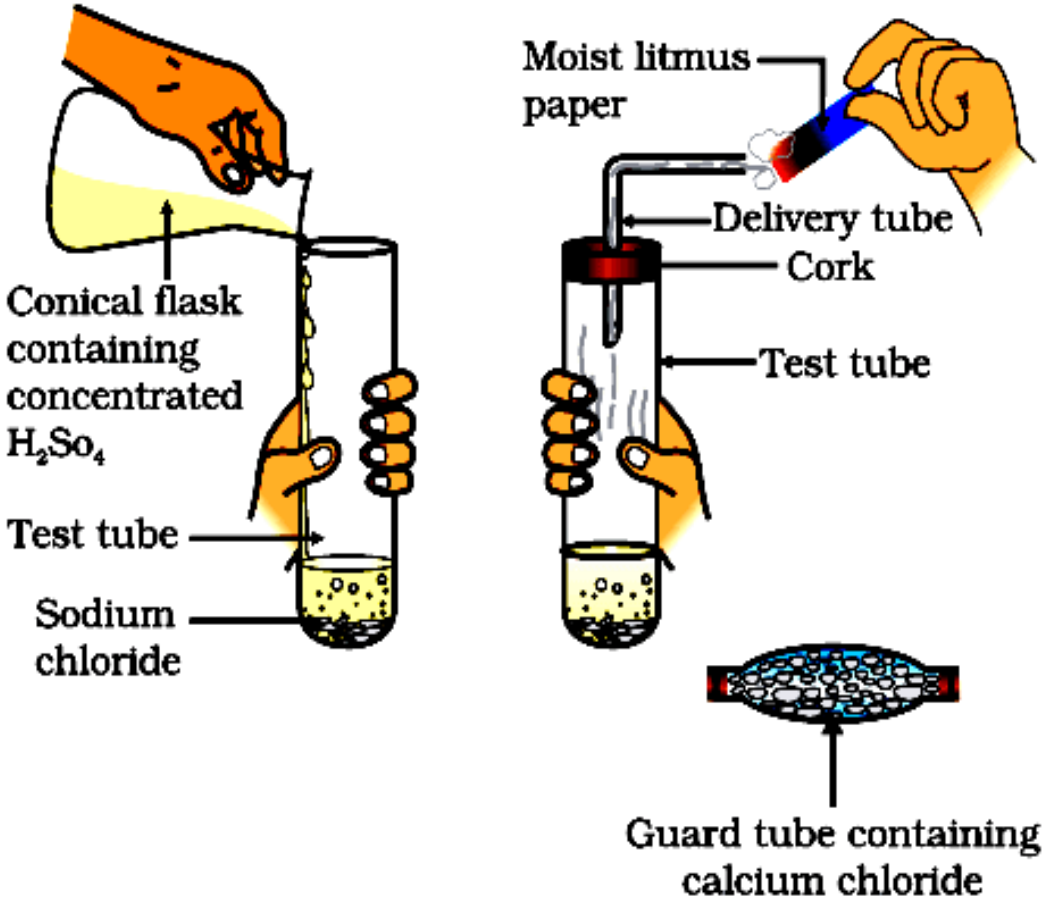


Acid solution in water conducts electricity

Glowing of the bulb indicates that there is a flow of electric current through the solution. The electric current is carried through the solution by ions.

Since the cation present in acids is H^+, this suggests that acids produce hydrogen ions, $H^+(aq)$, in solution, which are responsible for their acidic properties.

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



Preparation of HCl *gas*

This experiment suggests that hydrogen ions in HCl are produced in the presence of water. The separation of H^+ ion from HCl molecules cannot occur in the absence of water.

Hydrogen ions cannot exist alone, but they exist after combining with water molecules. Thus hydrogen ions must always be shown as $H^+(aq)$ or hydronium ion (H_3O^+).

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

We have seen that acids give H_3O^+ or H^+ (aq) ion in water. Let us see what happens when a base is dissolved in water..

Bases generate hydroxide (OH^-) ions in water.
Bases which are soluble in water are called alkalis.

Do You Know?

All bases do not dissolve in water. An alkali is a base that dissolves in water. They are soapy to touch, bitter and corrosive. Never taste or touch them as they may cause harm. Which of the bases in the Table 2.1 are alkalis?

Now as we have identified that all acids generate $H^+(aq)$ and all bases generate $OH^-(aq)$, we can view the neutralisation reaction as follows –

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

$$H\boxed{X + M}OH \rightarrow MX + HOH$$

$$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$$

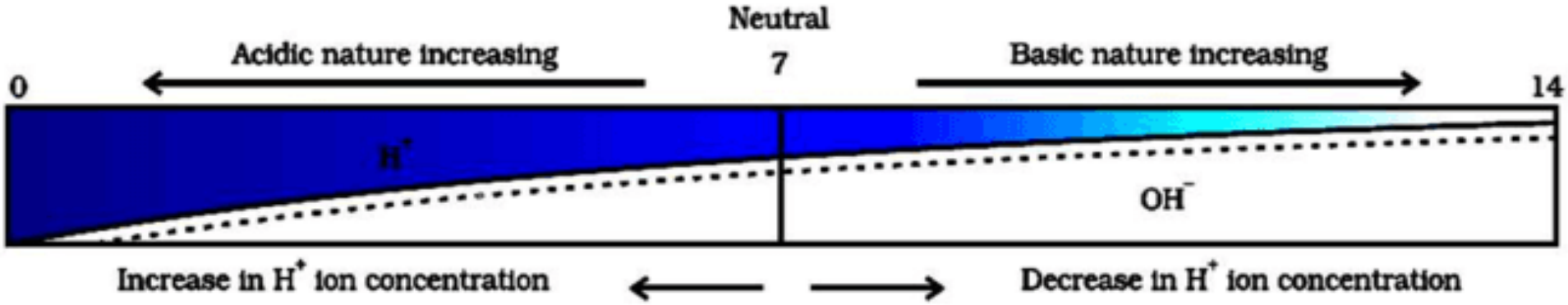
❖HOW STRONG ARE ACID OR BASE SOLUTIONS?

We Can quantitatively find the amount of H^+ or OH^- ions present in a solution, We Can also judge how strong a given acid or base. By making use of 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.

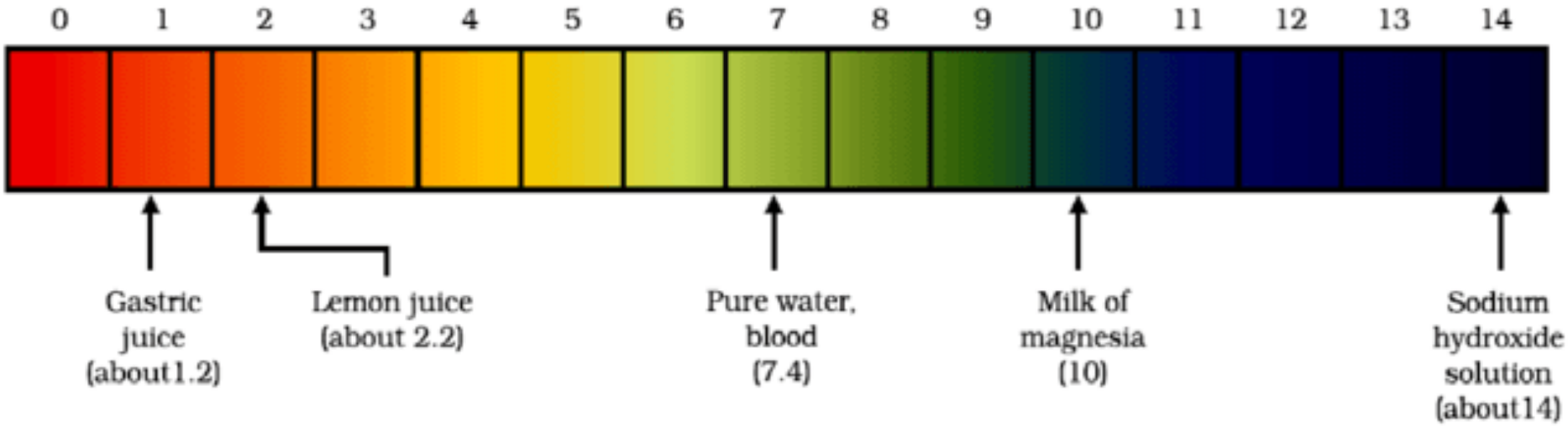
Ascale for measuring hydrogen ion concentration in a solution, called pH scale has been developed. The p in pH stands for 'potenz' in German, meaning power. On the pH scale we can measure pH from 0 (very acidic) to 14 (very alkaline). pH should be thought of simply as a number which indicates the acidic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

The pH of a neutral solution is 7. Values less than 7 on the pH scale represent an acidic solution. As the pH value increases from 7 to 14, it represents an increase in OH^- ion concentration in the solution, that is, increase in the strength of alkali.

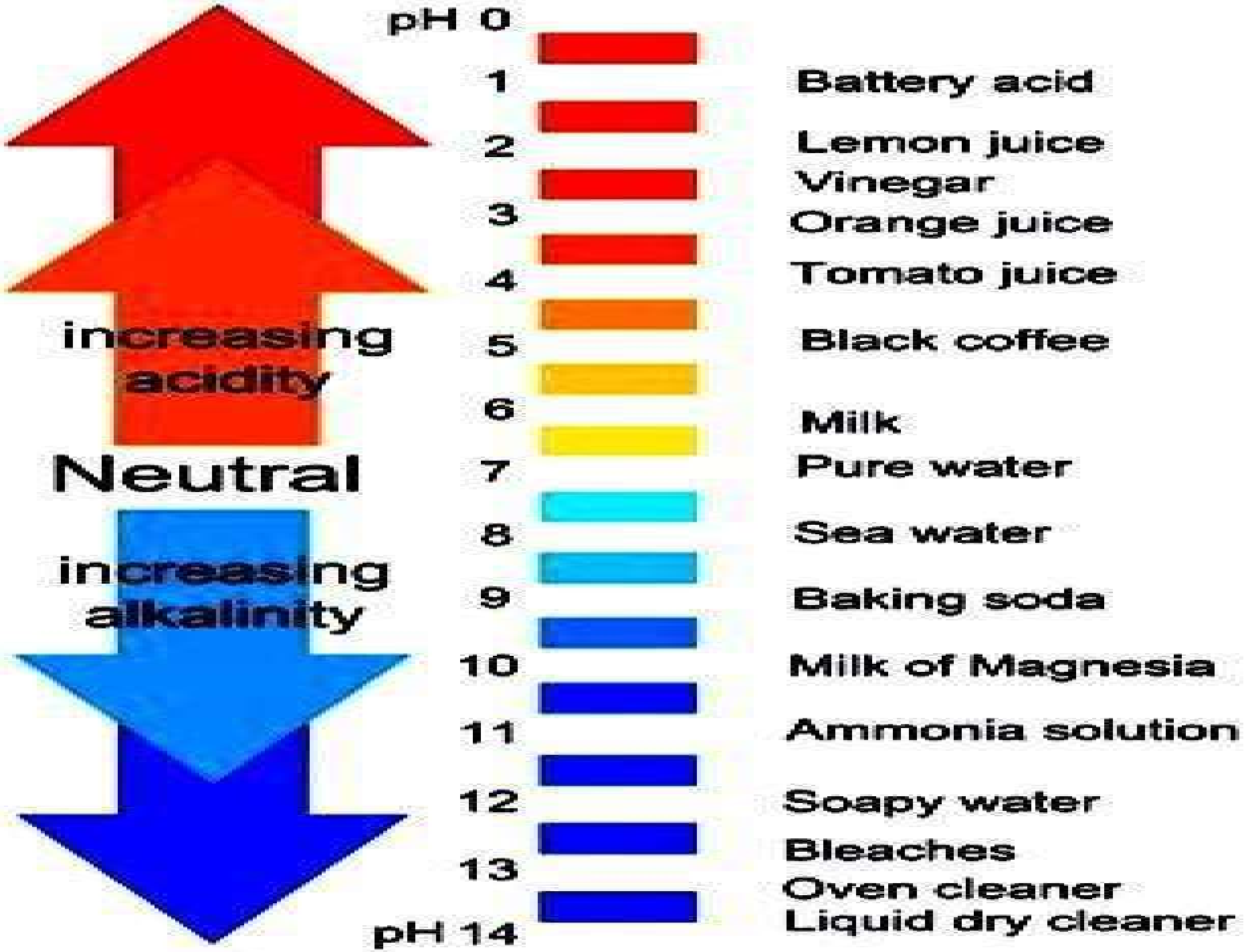
Generally paper impregnated with the universal indicator is used for measuring pH. One such paper is shown below



Variation of pH *with the change in concentration of* H^+(aq) *and* OH^-(aq) *ions*



pH *of some common substances shown on a* pH *paper*


pH 0
1
2
3
4
5
6
7
8
9
10
11
12
13
pH 14
Battery acid
Lemon juice
Vinegar
Orange juice
Tomato juice
Black coffee
Milk
Pure water
Sea water
Baking soda
Milk of Magnesia
Ammonia solution
Soapy water
Bleaches
Oven cleaner
Liquid dry cleaner
increasing acidity
Neutral
increasing alkalinity

pH Range for a Few Common Substances

Substance	pH Range
Gastric contents (human)	1.6–3.0
Soft drinks	2.0–4.0
Lemons	2.2–2.4
Vinegar	2.4–3.4
Tomatoes	4.0–4.4
Beer	4.0–5.0
Urine (human)	4.8–8.4
Milk (cow's)	6.3–6.6
Saliva (human)	6.5–7.5
Blood plasma (human)	7.3–7.5
Egg white	7.6–8.0
Milk of magnesia	10.5
Household ammonia	11–12

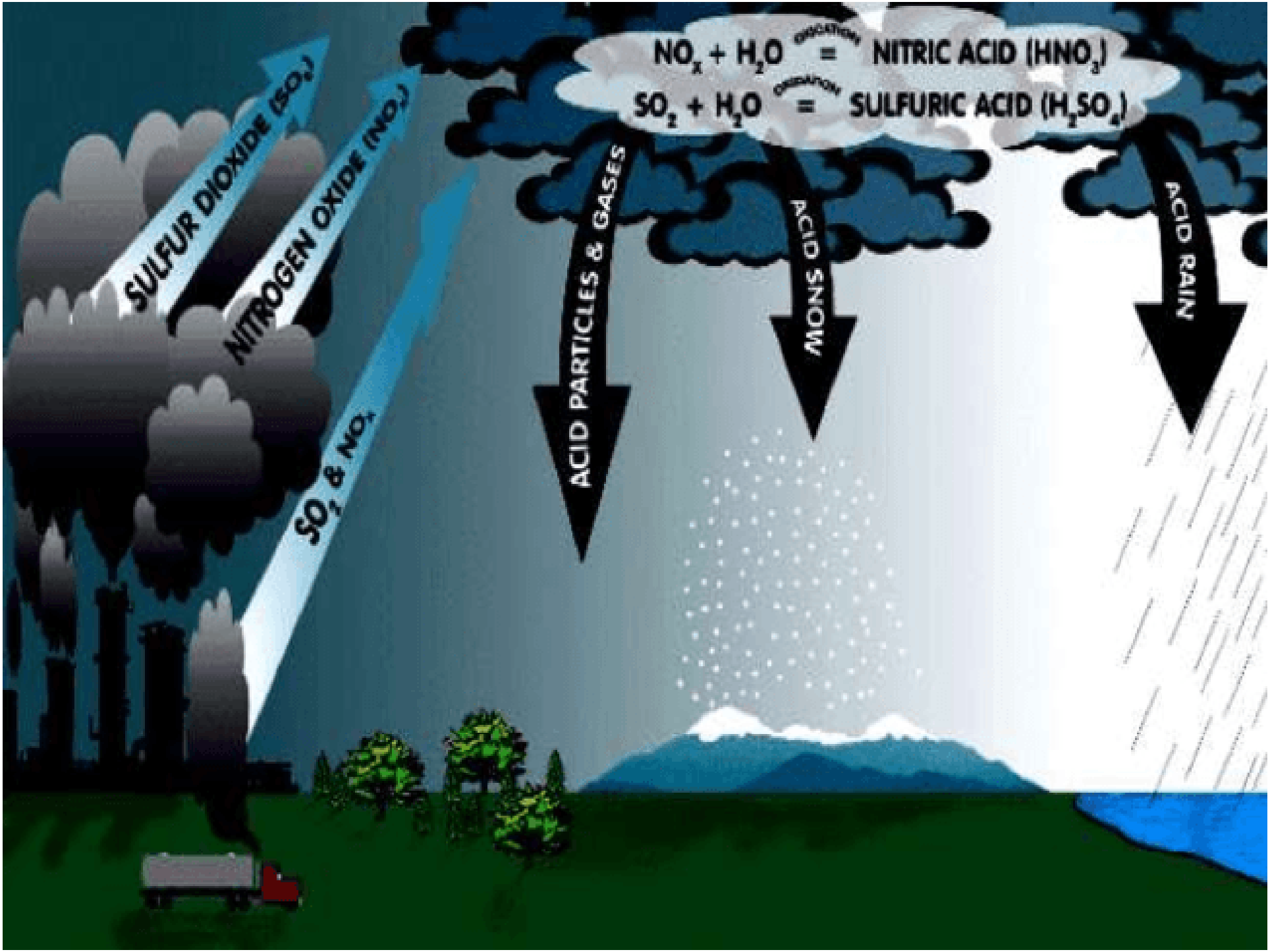

Household Cleaners
Pine
Missouri Household Hazardous Waste Project

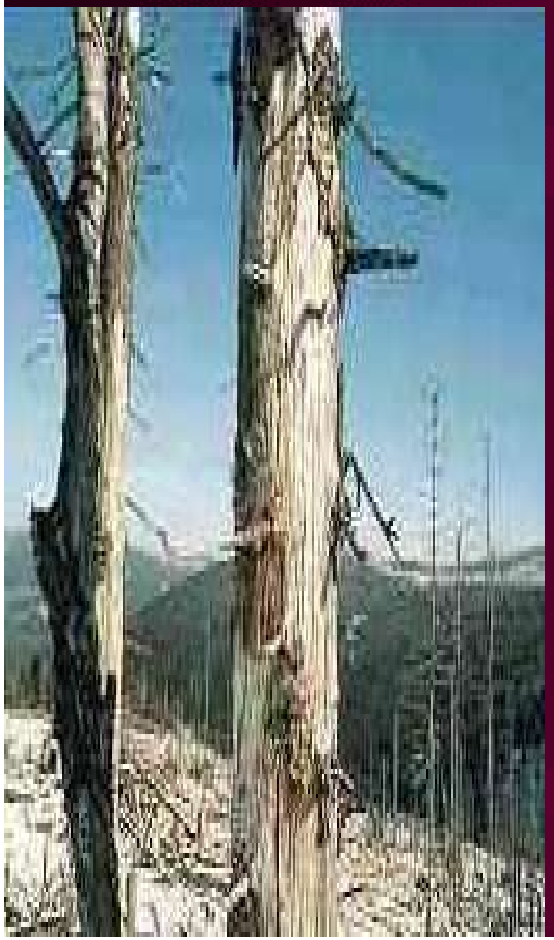
The strength of acids and bases depends on the number of H^+ ions and OH^- ions produced, respectively. If we take hydrochloric acid and acetic acid of the same concentration, say one molar, then these produce different amounts of hydrogen ions. Acids that give rise to more H^+ ions are said to be strong acids, and acids that give less H^+ ions are said to be weak acids.

Importance of pH in Everyday Life

✓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 range of pH change. 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


SULFUR DIOXIDE (SO_2)
NITROGEN OXIDE (NO_x)
SO_2 & NO_x
$NO_x + H_2O$ OXIDATION = NITRIC ACID (HNO_3)
$SO_2 + H_2O$ OXIDATION = SULFURIC ACID (H_2SO_4)
ACID PARTICLES & GASES
ACID SNOW
ACID RAIN



Acid rain can harm fish.

Do You Know?

Acids in other planets

The atmosphere of venus is made up of thick white and yellowish clouds of sulphuric acid. Do you think life can exist on this planet?

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

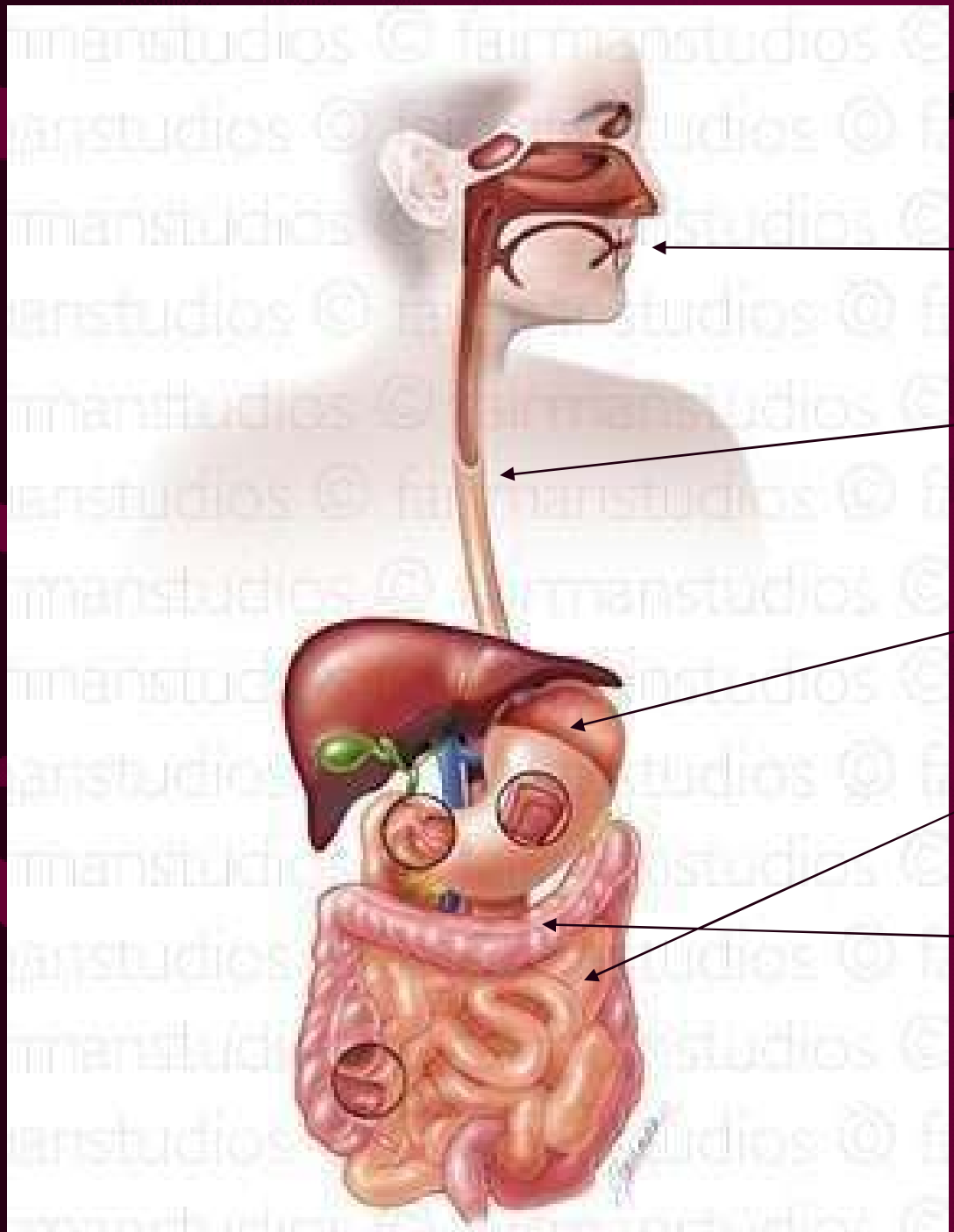
Plants require a specific pH range for their healthy growth. To find out the pH required for the healthy growth of a plant, you can collect the soil from various places and check the pH, Also, you can note down which plants are

✓pH in our digestive system

It is very interesting to note that 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. One such remedy must have been suggested by you at the beginning of this Chapter. These antacids neutralise the excess acid.

Digestive system



mouth

esophagus

stomach

small intestine

large intestine


GENUINE
Phillips'
Milk of Magnesia
LAXATIVE/ANTACID


ValuRite
EXTRA STRENGTH
Antacid
STOPS HEARTBURN FAST
100 CHEWABLE TABLETS

✓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 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

✓Self defence by animals and plants through chemical warfare

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

Do You Know?

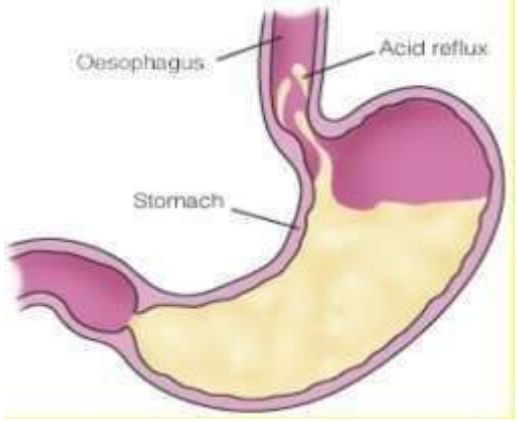
Nature provides neutralisation options

Nettle is a herbaceous plant which grows in the wild. Its leaves have stinging hair, which cause painful stings when touched accidentally. This is due to the methanoic 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. Can you guess the nature of the dock plant? So next time you know what to look out for if you accidentally touch a nettle plant while trekking. Are you aware of any other effective traditional remedies for such stings?

Some naturally occurring acids

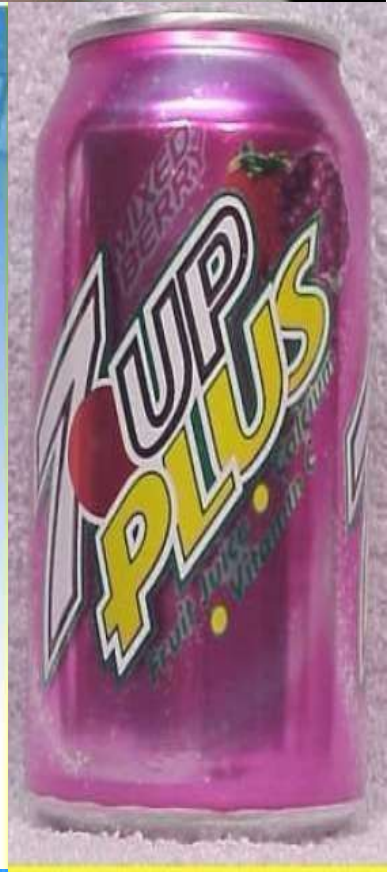
Natural source	Acid	Natural source	Acid
Vinegar	Acetic acid	Sour milk (Curd)	Lactic acid
Orange	Citric acid	Lemon	Citric acid
Tamarind	Tartaric acid	Ant sting	Methanoic acid
Tomato	Oxalic acid	Nettle sting	Methanoic acid


Vinegar


Oesophagus
Acid reflux
Stomach


BOSCH
AsiaSILVER
4BA


PEPSI


7UP
PLUS

USES OF SALTS

S.No.	SALT	USE
1	Ammonium Chloride	In torch batteries
2	Ammonium Nitrate	In fertilizers
3	Calcium Chloride	As drying agent
4	Iron Sulphate	In Iron tablets
5	Magnesium Sulphate	In medicine
6	Potassium Nitrate	In gunpowder etc.
7	Silver Bromide	In photography
8	Sodium Chloride	Making NaOH
9	Sodium Stearate	In making soap.

Salts having the same positive or negative radicals are said to belong to a family. For example, NaCl and Na2SO4 belong to the family of sodium salts. Similarly, NaCl and KCl belong to the family of chloride salts.

➢pH of salts—

Salts of a strong acid and a strong base are neutral with pH value of 7. On the other hand, salts of a strong acid and weak base are acidic with pH value less than 7 and those of a strong base and weak acid are basic in nature, with pH value more than 7.

Chemical from common salts

The salt formed by the combination of hydrochloric acid and sodium hydroxide solution is called sodium chloride. This is the salt that we use in food. it is a neutral salt.

Seawater contains many salts dissolved in it. Sodium chloride is separated from these salts. 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.

Common salt – A raw material for chemicals

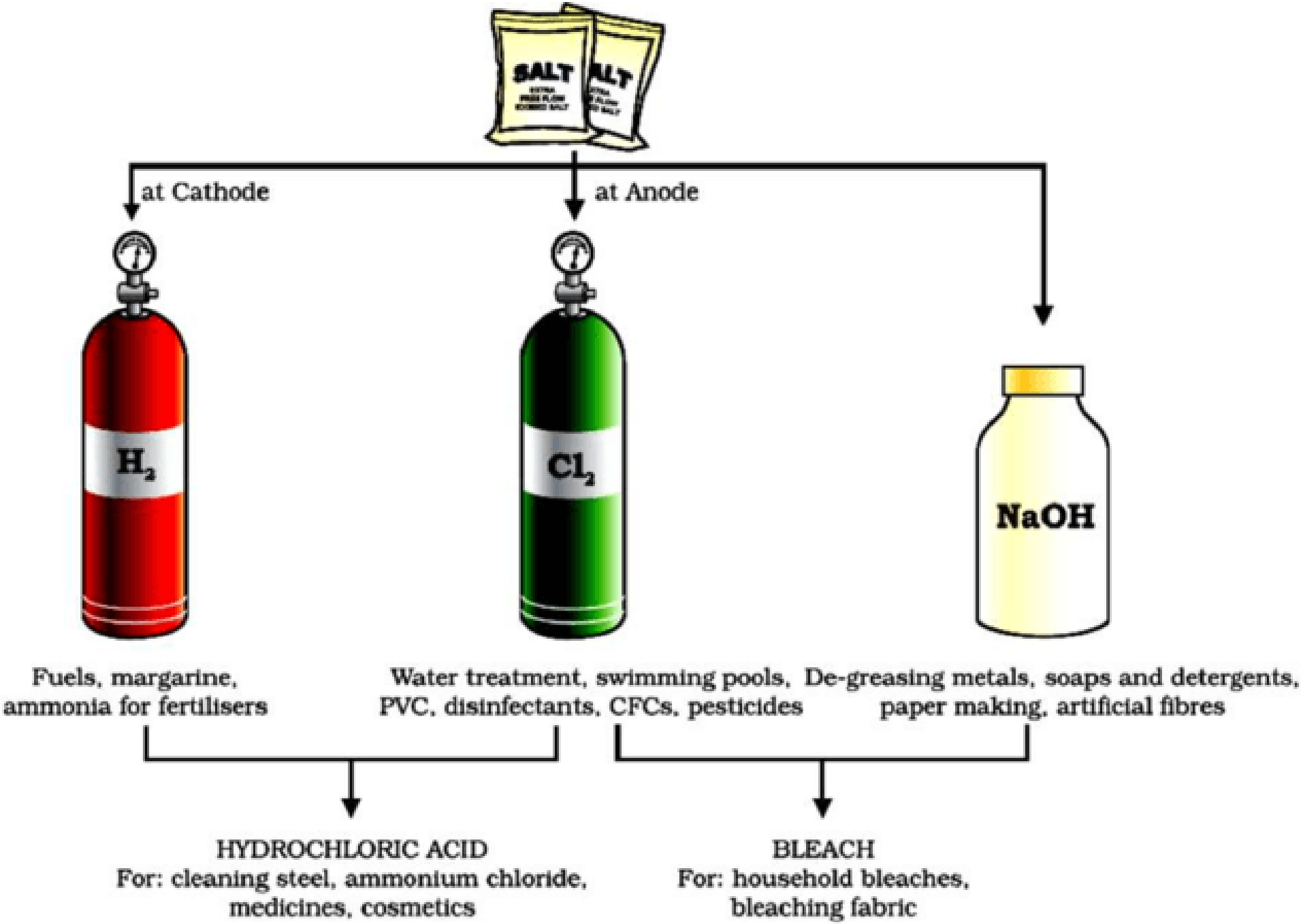
The common salt thus obtained is an important raw material for various materials of daily use, such as sodium hydroxide, baking soda, washing soda, bleaching powder and many more. Let us see how one substance is used for making all these different substances.

✓Sodium hydroxide:

When electricity is passed through an aqueous solution of sodium chloride (called brine), it decomposes to form sodium hydroxide. The 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. The three products produced in this process are all useful.



Important products from the chlor-alkali process

✓Bleaching powder:

You have already come to know that chlorine is produced during the electrolysis of aqueous sodium chloride (brine). This chlorine gas is used for the manufacture of bleaching powder. Bleaching powder is produced by the action of chlorine on dry slaked lime [$Ca(OH)_2$]. Bleaching powder is represented as $CaOCl_2$, though the actual composition is quite complex.

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

Bleaching powder is used –
(i)for bleaching cotton and linen in the textile industry, for bleaching wood pulp in paper factories and for bleaching washed clothes in laundry;
(ii)as an oxidising agent in many chemical industries; and
(iii)for disinfecting drinking water to make it free of germs.

✓Baking soda:

The soda commonly used in the kitchen for making tasty crispy pakoras is baking soda. Sometimes it is added for faster cooking. The chemical name of the compound is sodium hydrogencarbonate ($NaHCO_3$). It is produced using sodium chloride as one of the raw materials.

$$NaCl + H_2O + CO_2 + NH_3 \rightarrow \underset{\text{(Ammonium chloride)}}{NH_4Cl} + \underset{\text{(Sodium hydrogencarbonate)}}{NaHCO_3}$$

It is a mild non-corrosive base. The following reaction takes place when it is heated during cooking –

$$\underset{\text{(Sodium hydrogencarbonate)}}{2NaHCO_3} \xrightarrow{\text{Heat}} \underset{\text{(Sodium carbonate)}}{Na_2CO_3} + H_2O + CO_2$$

Uses of sodium hydrogencarbonate ($NaHCO_3$)

(i)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, the following reaction takes place –

$$NaHCO_3 + H^+ \text{ (From any acid)} \rightarrow CO_2 + H_2O + \text{Sodium salt of acid}$$

Carbon dioxide produced during the reaction causes bread or cake to rise making them soft and spongy.

(ii)Sodium hydrogencarbonate is also an ingredient in antacids. Being alkaline, it neutralises excess acid in the stomach and provides relief.

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

✓Whasing soda:

Another chemical that can be obtained from sodium chloride is $Na_2CO_3.10H_2O$ (washing soda). You have seen above that sodium carbonate can be obtained by heating baking soda; recrystallisation of sodium carbonate gives washing soda. It is also a basic salt.

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

(Sodium carbonate)

Uses of washing soda

(i)Sodium carbonate (washing soda) is used in glass, soap and paper industries.

(ii)It is used in the manufacture of sodium compounds such as borax.

(iii)Sodium carbonate can be used as a cleaning agent for domestic purposes.

(iv)It is used for removing permanent hardness of water.

✓Plaster of Paris:-

On heating gypsum at 373 K, it loses water molecules and becomes calcium sulphate hemihydrate . This is called Plaster of Paris, the substance which doctors use as 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.

$$\underset{\text{(Plaster of Paris)}}{CaSO_4 \cdot \frac{1}{2} H_2O} + 1\frac{1}{2} H_2O \rightarrow \underset{\text{(Gypsum)}}{CaSO_4 \cdot 2H_2O}$$

It is written in this form because two formula units of CaSO4 share one molecule of water. Plaster of Paris is used for making toys, materials for decoration and for making surfaces smooth.