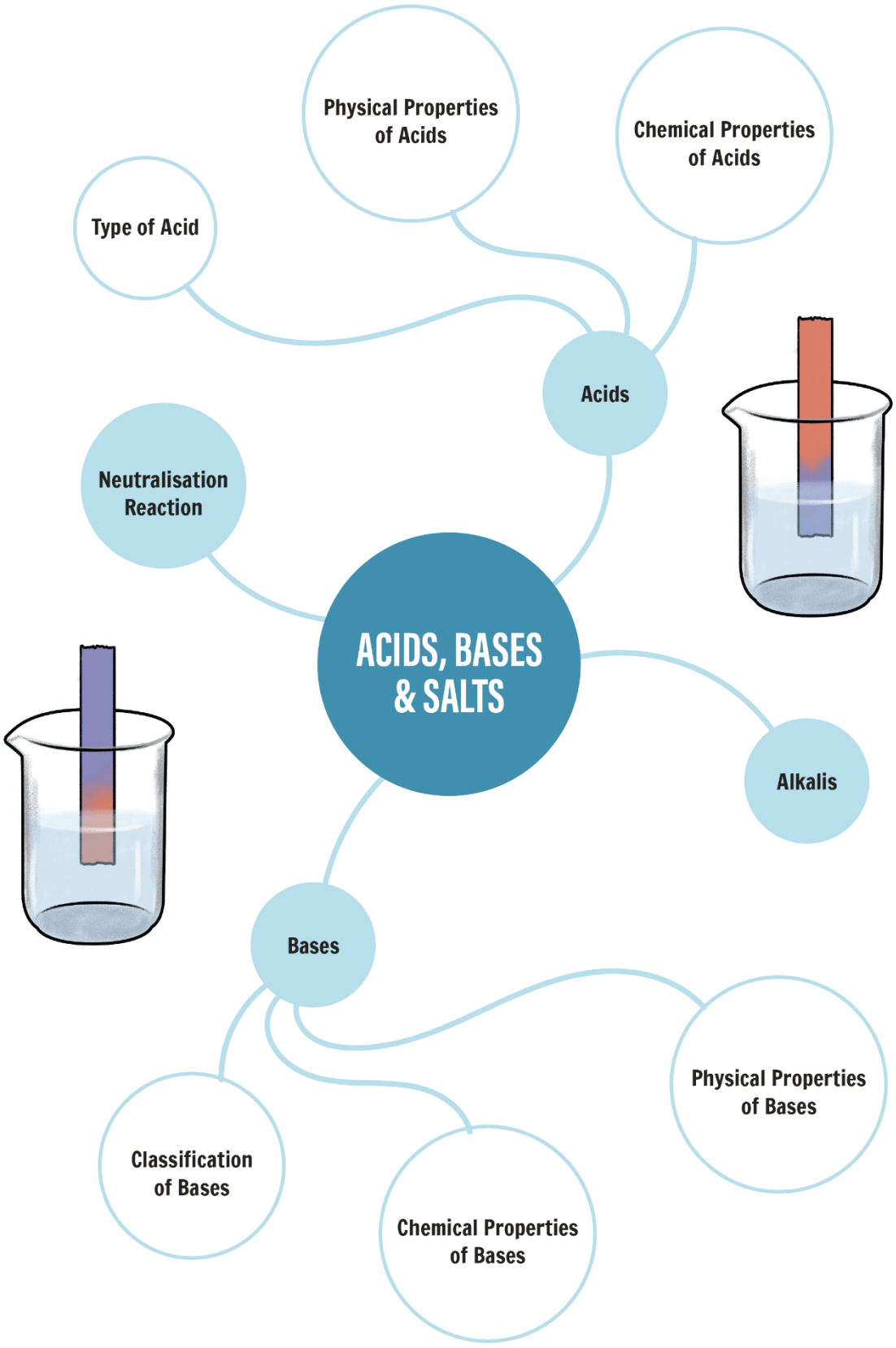
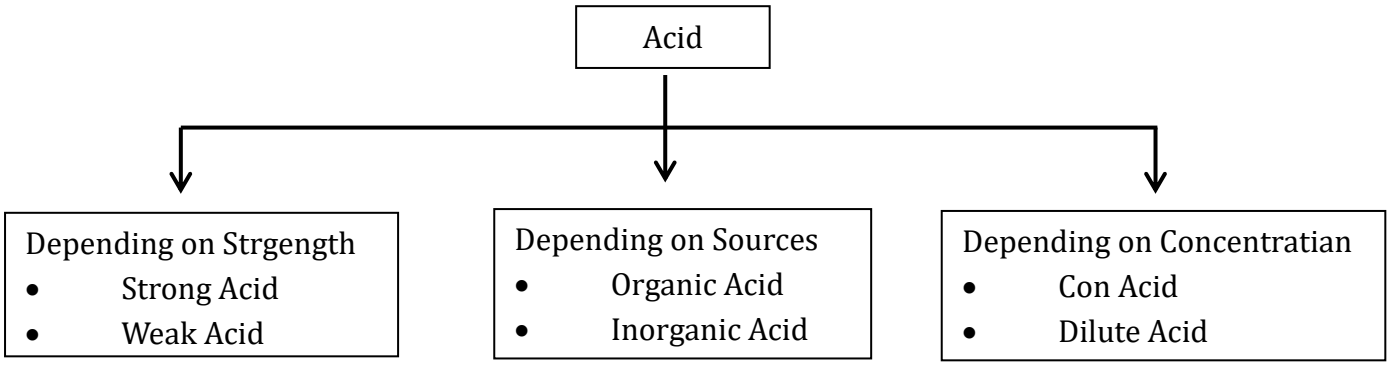

ACIDS, BASES & SALTS
Acids
Physical Properties of Acids
Chemical Properties of Acids
Type of Acid
Neutralisation Reaction
Alkalis
Bases
Physical Properties of Bases
Classification of Bases
Chemical Properties of Bases

Acids, Base and Salts

Acids

- Acids generally are those chemical substances which have a sour taste
- Acid changes the colour of between litmus solution to Red.
- An Acid is a substance which contains hydrogen ion and produces H^+ ion in its aqueous solution.



Depending on Strength

Strength of an Acid means; to what extent dissociation of an acid takes place in a solution,

More the dissociation of an Acid, more the Acidity

A) Strong Acids:

Ionize completely in their aqueous solution and hence produce a large Number of Hydronium ions and hence produce a large Number of Hydronium ions

$HCl \rightleftharpoons H^+ + Cl$

$H_2O + H^+ \rightleftharpoons H_3O^+$

Example: HCl, H_2SO_4, HNO_3

B) Weak Acid:

These ionize partially in their aqueous solution, hence produces less Hydronium ion.

Example: Acetic Acid (CH_3COOH)

Formic Acid $(HCOOH)$

Depending on Source

A) Organic Acid:

Organic Acids are those which are obtained from plants or Animals and are naturally occuring.

Organic Acids are generally weak Acids and do not ionise completely.

Example: Acetic Acid (CH_3COOH)

Oxalic Acid $\begin{pmatrix} COOH \\ | \\ COOH \end{pmatrix}$

Formic Acid ($HCOOH$)

- Red ants → Formic Acid
- Tea → Tannic Acid
- Gastric Juice → Hydrochloric Acid
- Tomato → Oxalic Acid
- Curd → Lactic Acid
- Vinegar → Acetic Acid
- Tamarind (imli) → Tartaric Acid
- Apple → Malic Acid

B) Inorganic Aicd or Mineral Acid:

- These Acids are Not present in Nature
  Example: $HCl, HNO_3, H_2SO_4, HNO_2$, etc.
- These Acids are generally strong acids.
- These Acids show 100% dissociation.

Depending on Concentration

Concentration of an Acid means the amount of acid present in fixed amount of it's aqueous solution.

A) Concentrated Solution:

A large amount of acid is present in a fixed amount of it's aqueous solution

B) Dilute Acids:

A small amount of acid is present in a fixed amount of it's aqueous solution.

Properties of Acids

- Acids have sour taste, Mineral acids like H_2SO_4, HCl are
- Acids are generally solid or liquids at Room temp.
- It changes colour of between litmus to Red litmus.
- They are corrosive-in Nature
- They are good electrolyte (Conduct electricity)

Chemical Properties of Acids

A) Reaction with Active Metals:

Acids when react with active metals like Na Potassium (K) eH. Evolve H_2 gas which burn with PoP sound.

Acid + Metal ⟶ Salt + Hydrogen gas

Examples:

i) $Mg(s) + 2HCl(aq) \longrightarrow MgCl_2(aq) + H_2(g) \uparrow$

ii) $Fe + H_2SO_4 \longrightarrow FeSO_4 + H_2 \uparrow$

iii) $Zn + 2HCl \longrightarrow ZnCl_2 + H_2 \uparrow$

B) Reaction with Bases (Neutralization Reaction)

Base + Acid ⟶ Salt + Water

Neutralization point is the state where the substance loses it's Acidic or Basic Nature and in become Neutral.

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

C) Reaction with Metal carbonates and Metalhydrogen Carbonates

It gives salt of respecive metal, CO_2 and water.

Metal carbonate + Acid ⟶ Salt + CO_2 + H_2O

Metal Hydrogen Carbonate + Acid ⟶ Salt + CO_2 + H_2O

Examples:

$2HCl(aq) + Na_2CO_3(s) \longrightarrow 2NaCl(aq) + H_2O + CO_2$

$HCl(aq) + NaHCO_3(s) \longrightarrow NaCl(aq) + H_2O + CO_2$

$2HBr(aq) + Na_2CO_3 \longrightarrow 2NaBr + H_2O(l) + CO_2(g)$

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

$HBr(aq) + NaHCO_3(aq) \longrightarrow NaBr(aq) + H_2O(l) + CO_2(g)$

On passing excess of CO_2

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

D) Reaction with Metal Oxide:

Metal Oxide + Acid ⟶ Salt + Water

Example:

$CaO(s) + 2HNO_3(aq) \longrightarrow Ca(NO_3)_2(aq) + H_2O(l)$

$CuO + 2HCl \longrightarrow CuCl_2 + H_2O$

Acids do no show Acidic Behaviour in the Presence of water.

- The Acidic Behaviour of Acid id due to the presence of H^+ ion (aq)
- The Acid Produces ions only in the presence of water
- In the Absence of water, a substance will not form hydrogen ion and Hence will not shw its acidic behaviour

Dry HCl gas does not changes the colour of dry litmus paper, while HCl gas dissolved in water it form hydrogen ions and Hence shows Acidic behaviour.

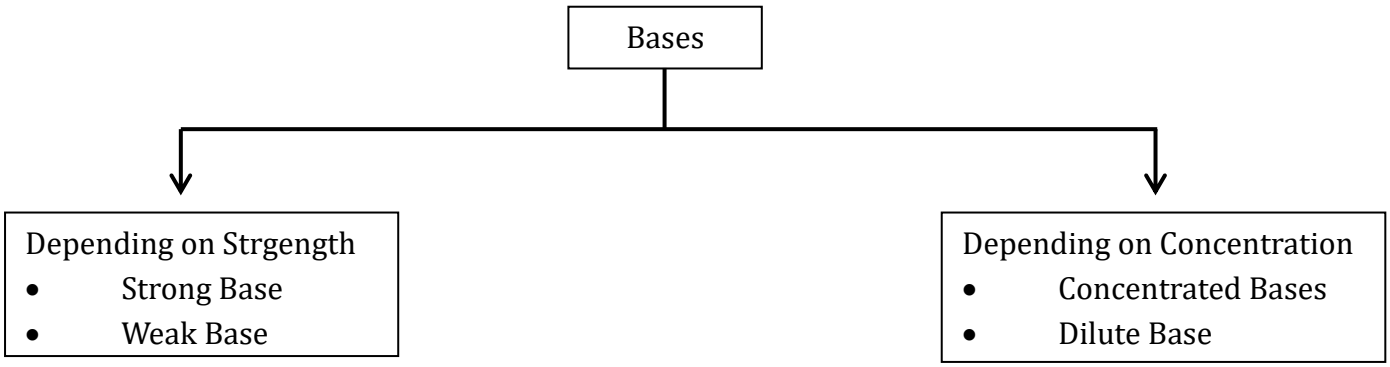
Q. Why does an aqueous solution of an acid conduct electricity?

Sol. The aqueous solution of an acid conducts electricity due to the presence of charged particles called ions in it.

Bases

A base is a compound, when dissolved in water, produces Hydroxylion $(\overline{O}H)$ as the Negative ion.

Classification of Bases



Depending on Strength

A) Strong Base:

Those bases that ionize completely in aqueous solution and give a high concentration of $\overline{O}H$ ions.

Example:

$NaOH(aq) \longrightarrow Na^{+} + \overline{O}H(aq)$

$KOH(aq) \longrightarrow K^{+}(aq) + \overline{O}H(aq)$

B) Weak Base:

Those ionize particelly in aqueous solution and gives concentration of $\overline{O}H$ ion.

$NH_4OH(aq) \rightleftharpoons NH_4^{+} + \overline{O}H(aq)$

$Ba(OH)_2 \rightleftharpoons Ba^{2+} + 2\overline{O}H(aq)$

Depending on Concentration

A) Concentrated Bases:

When a high amount of a base is present in a fixed amount of solution.

B) Diluted Bases:

When a less amount of base is present in a fixed amount of solution

Properties of Bases

A) Physical Properties:

- Bases have a bitter taste
- Bases are generally solid or liquid
- Good electrolytes
- They have a corrosive action. (slight burn on the skin)

B) Chemical Properties:

- Reaction with Acids

  Base + Acid $\longrightarrow$ Salt + Water

  $NaOH + HCl \longrightarrow NaCl + H_2O$

- Reaction with Metal

  Hydrogen gas is evolved when bases react with Metals

  $2NaOH(aq) + Zn(s) \longrightarrow nA_2zNo_2(aq) + H_2(g) \uparrow$

C) Action of Non-Metal Oxides:

Strong Alkali Absorbs CO_2 from air to form carbonate

$2NaOH + CO_2 \longrightarrow Na_2CO_3 + H_2O$

Alkalis

Alkalis are water soluble Bases that furnish $\overline{O}H$ ions in aqueous solution.

An Alkali is a Basic Hydroxide which can dissolve in water produces hydroxide ions $(\overline{O}H)$

All the alkalis are Bases But, all Bases are Not alkalis

Acid and Bases Conduct Electricity

Let us discuss an Experiment:

- Take solution of HCl, H_2SO_4, glucose and Alcohal
- Fix two iron Nails on a Rubber cork and place the cork in the beaker and connect the nails to the terminal of a 6 volt Battery
- Four some Dilute HCl solution in the Beaker and Switch on the current, the Bulb start glowing
- If we repeat the same experiment with H_2SO_4 glucose and Alcohol, we will find that H_2SO_4 soltuion will conduct electricity, while glucose and Alcohal do not conduct electricity.

Neutralisation Reaction

Reaction Between Acid and Bases to form salt and water Neutralisation is an exothermic Reaction/Process

Application of Neutralization

- Slaked Lime $[Ca(OH)_2]$ is added to Reduce the acidity of soil.
- Sting of Ants/bees containing HCOOH

Chemical Equation

A chemical equation is the symbolic representation of a chemical reaction in the form of symbols and formula

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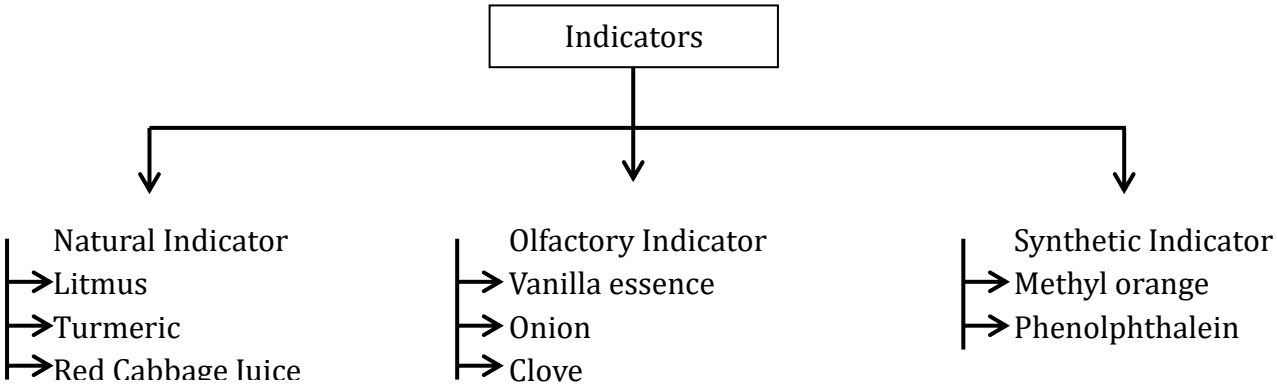
Indicators

"Indicators are chemicals which change their colour in the presence of the acid or base."



Natural Indicator

Indicator	**Smell Colour in acidic solution**	**Smell Colour in basic solution**
Litmus	Red	Blue
Red Cabbage leaf extract	Red	Green
Turmeric	No change	Red

Litmus solution

Is the Purple dye, extracted from the plant belonging to the division **Thallophyta** named lichen.

Coloured petals

Some flowers such as hydrangea petunia, Geranium and China Rose. Which Indicate the presence of Acid and Base.

Olfactory Indicator

Indicator	**Smell Colour in acidic solution**	**Smell Colour in basic solution**
Onion	Characteristic smell	No smell
Vanilla Essence	Retains smell	No smell
Clove oil	Retains smell	Loses smell

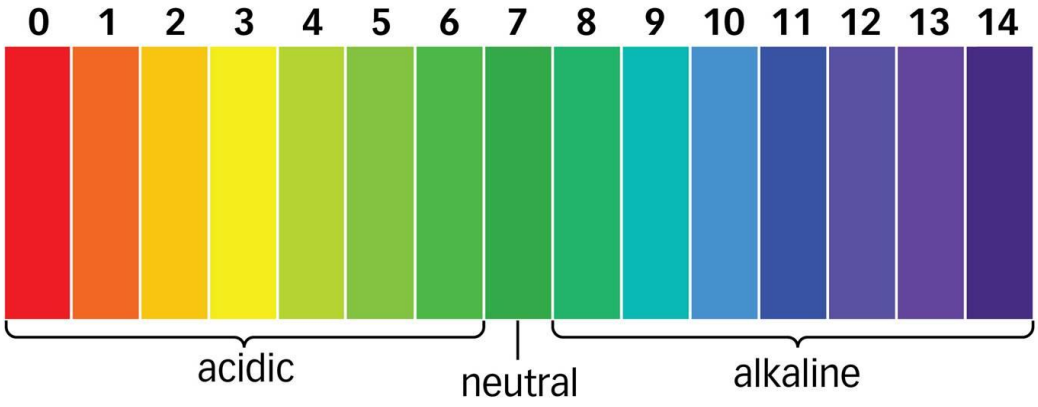
Synthetic Indicator

Indicator	**Smell colour in acidic solution**	**Smell colour in basic solution**
Phenolphthalein	Colourless smell	Pink
Methyl orange	Red	Yellow

Concept of pH

- Strength of acid and base is given in terms of pH.
- pH in German means potenz of Hydrogen that is power of Hydrogen.
- The strength of acid and base depends upon the number of H^+ and ^-OH ions produced in aq solution.

pH scale



- All substances having pH value between O and 7 are acidic in Nature.
- pH value between 7 and 14 are basic in Nature.
- pH = 7 (Neutral)
- Strength of acid and base depends on number of H^+ ions and ^-OH ions produced.

Q. You have two solutions A and B. The pH of solution A is 6 and pH of solution B is 8. Which solution has more hydrogen ion concentration? Which of this is acidic and which one is basic?

Sol. A pH value of less than 7 indicates an acidic solution, while greater than 7 indicates a basic solution. Since solution A has more hydrogen ion concentration, solution A is acidic and solution B is basic.

Q. What effect does the concentration of H+ (aq) ions have on the nature of the solution?

Sol. More the concentration of H+ ions, higher the acidic nature of the solution.

Importance of pH in everyday life

1) In humans and plants

- Most of the reactions taking place in our body are in the pH range of 7.0 to 7.8. If pH falls below 7.0 or rises above 7.8, the survival of living organisms become difficult.

2) In digestive system

- HCl is produced in our stomach which help in digestion in food. But if the amount of acid produced increases it cause pain and irritation.

3) Tooth decay caused by acids

- If the pH in our mouth falls below 5.5, the dissolution of **calcium phosphate** (tooth enamel) starts.

4) Self defence of animals and plants through chemical warfare

- Sting of honey-bee injects methanoic acid (or formic acid) due to which we feel pain. To get relief, a solution of mild base, such as baking soda is used. Stinging hair of nettle leaves inject methanoic acid, causing burning pain.

Salts

Salts are the ionic compounds which contains a positive ion (cation) and negative ion (anion) e.g., NaCl, NaNO3, MgCl2.

1) Neutral salts

Strong acid + strong base → Neutral salt

2) Acidic salts

Strong acid + weak base → Acidic salt

3) Basic salts

Strong base + weak acid → Basic salt

Common salt

- Sea water is one of the main source of common salt.
- To extract the salt from sea water, it is allowed to evaporate.

Properties of common salt

- It is essential constituent of our diet.
- It is slightly hygroscopic in nature.
- It is soluble in water.

Uses of common salt

- It is essential constituent of our diet.
- It is used to make freezing mixture (ice-creams).
- It is used as raw material for caustic soda, bleaching powder, baking soda and washing soda.

Sodium hydroxide (caustic soda)

Sodium hydroxide is prepared by electrolysis of an aqueous solution of sodium chloride (brine). This method is called chlor-alkali process.

$$2NaCl(aq) + 2H_2O_{(l)} \xrightarrow[\text{electricity}]{\text{On passing}} 2NaOH_{(aq)} + Cl_{2(g)} + H_{2(g)}$$

The Sodium hydroxide solution is prepared near cathode.

Uses:

1) For making soap and detergents.
2) For degreasing metals.
3) In making of artificial fibres.
4) In petroleum refining.
5) As a laboratory reagent.

Bleaching powder

It is prepared by the action of chlorine gas on dry slaked lime $Ca(OH)_2$.

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

The chlorine used in the above reaction is the by product of electrolysis of brine.

Uses:

1) In textile industry for bleaching cotton and linen.
2) In paper industry for bleaching wood pulp.
3) In laundry for bleaching washed clothes.
4) For disinfecting drinking water.

Baking soda

When an aqueous solution of sodium chloride (brine) saturated with ammonia is allowed to react with carbon dioxide, baking soda is produced along with ammonium chloride.

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

This process is known as 'Solvay process.

Uses:

1) For making baking powder.
2) As an antacid.
3) As an additive in food and drinks.
4) In fire-extinguishers.

Washing soda

The preparation of washing soda is carried out through following steps:

Step-1 : Manufacture of sodium hydrogen carbonate.

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

Step-2 : Thermal decomposition of sodium hydrogen carbonate.

$$2NaHCO_3 \xrightarrow{\text{Heat}} Na_2CO_3 + CO_2 + H_2O$$

Step-3 : Recrystallisation of sodium carbonate.

$$2Na_2CO_3 + 10H_2O \rightarrow Na_2CO_3$$

Uses:

1) For softening of hard water.
2) For washing purpose in laundry and as cleaning agent for domestic purpose.
3) In textile industries and also in petroleum refining.
4) In the manufacturing of borax.

Plaster of paris

It is prepared by heating gypsum ($CaSO_4.2H_2O$) at 373 K.

$$CaSO_4.2H_2O \xrightarrow{\text{Heat}} CaSO_4.\ \frac{1}{2}\ H_2O + 1\frac{1}{2}\ H_2O$$

Uses:

1) For making moulds for toys, pottery, ceramics, etc.

2) For making statues, models and other decorative materials.

3) As fire proofing materials.

4) In medical science as plaster for setting broken and fractured bones.

Water of crystallisation

It is the fixed number of water molecules present in one formula unit of a salt. E.g., Gypsum ($CaSO_4.2H_2O$) has tow molecules of water of crystallization.

In hydrated copper sulphate ($CuSO_4.5H_2O$), there are five molecules of water of crystallization.

Important NCERT Questions

Q1. Write word equations and then balanced equations for the reaction taking place when

(a) dilute sulphuric acid reacts with zinc granules

(b) dilute hydrochloric acid reacts with magnesium ribbon

(c) dilute sulphuric acid reacts with aluminium powder

(d) dilute hydrochloric acid reacts with iron filing

Sol. (a) Zinc + dilute sulphuric acid → Zinc sulphate + Hydrogen

$$Zn\,(s) + H_2SO_4\,(aq) \rightarrow ZnSO_4\,(aq) + H_2\,(g)$$

(b) Magnesium ribbon + dil. Hydrochloric acid → Magnesium chloride + Hydrogen

$$Mg\,(s) + 2HCl\,(aq) \rightarrow MgCl_2\,(aq) + H_2\,(g)$$

(c) Aluminium powder + dil. Sulphuric acid > Aluminium sulphate + Hydrogen

$$2Al(s) + 3H_2SO_4\,(aq) \rightarrow Al_2\,(SO_4)_3\,(aq) + 3H_2(g)$$

(d) Iron filings + Dilute hydrochloric acid > Ferric chloride + Hydrogen

$$2Fe(s) + 6HCl(aq) \rightarrow 2FeCl_3\,(aq) + 3H_2(g)$$

Q2. Why does distilled water not conduct electricity, whereas rainwater does?

Sol. Distilled water does not conduct electricity because it does not contain any ionic compound (like acids, bases or salts) dissolved in it.

Rainwater, while falling to the earth through the atmosphere, dissolves an acidic gas carbon dioxide from the air and forms carbonic acid (H_2CO_3). Carbonic acid provides hydrogen ions, H+ (aq) and carbonate ions, $CO(aq)_3^2$ to rainwater. Hence, due to the presence of carbonic acid which provides ions to rainwater, the rainwater conducts electricity.

Q3. Why do acids not show acidic behaviour in the absence of water?

Sol. The acidic behaviour of acids is due to the presence of hydrogen ions, [H+ (aq) ions], in them. The acid produces hydrogen ions only in the presence of water. So in the absence of water, an acid will not form hydrogen ions and hence will not show its acidic behaviour.

Q4. Five solutions A, B, C, D and E when tested with universal indicator showed pH as 4, 1, 11, 7 and 9 respectively. Which solution is

(a) Neutral **(b) Strongly alkaline** **(c) Strongly acidic**

(d) Weakly acidic **(e) Weakly alkaline**

Arrange the pH in increasing order of hydrogen ion concentration.

Sol. (a) D (b) C (c) B

(d) A (e) E

Increasing order of hydrogen ion concentration

$11 < 9 < 7 < 4 < 1$

i. e., C < E < D < A < B

Q5. Equal lengths of magnesium ribbons are taken in test tubes A and B. Hydrochloric acid (HCl) is added to test tube A, while acetic acid (CH_3COOH) is added to test tube B. In which test tube will the fizzing occur more vigorously and why?

Sol. Fizzing will occur more vigorously in test tube A. Hydrochloric acid (HCl) is a strong acid whereas acetic acid (CH_3COOH) is a weak acid. Being strong acid, the hydrochloric acid solution contains a much greater amount of hydrogen ions in it due to which the fizzing will occur more vigorously in test tube A (containing hydrochloric acid). The fizzing is due to the evolution of hydrogen gas which is formed by the action of acid on the magnesium metal of magnesium ribbon.

Q6. fresh milk has a pH of 6. How do you think the pH will change as it turns into curd? Explain your answer.

Sol. pH of milk falls below 6 as it turns into curd due to the formation of lactic acid during this process. Lactic acid present in it reduces its pH value.