ACIDS, BASES & SALTS

INTRODUCTION –

A wide variety of material consists essentially of elements and compounds having different characteristics exist around us. Some of than are sour, some are bitter, while some are salty in tested.

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

Acids react with bases to produce salt whose properties are different from acid and base.

ACIDS –

The term " acid is derived form the Latin word "**acidus"** meaning sour taste.

Example – Sour taste of lemon, unripened grapes, Vinegar, tomatoes etc.

According to Arrhenius theory:

"An acid is a substance which dissolved in water, it ionizes and releases hydrogen ions [H^+(aq.)] in solution".

$$HCl\ (aq.) \longrightarrow H^+\ (aq.) + Cl^-(aq.)$$

Hydrochloric acid Hydrogen ion Chloride ion

$$\text{Or}\quad HCl\ (g) + H_2O\ (l) \longrightarrow H_3O(aq.)^{\oplus} + Cl^-(aq.)$$

Note:- Hydrogen ion do not exist as H^+ ions in solution, they attach themselves to the polar water molecules to from hydronium ions or hydroxonium ions, (H_3O or $H^+(aq.)^{\oplus}$

$$H^+ + H_2O \quad H_3O^+$$

Hydrogen ion Water Hydronium ion

$$H_2SO_4(aq.) \longrightarrow 2H^+\ (aq.) + SO^{2-}{}_4(aq.)$$

Sulphuric acid Hydrogen ion Sulphate ion

$$HNO_3(aq.) \longrightarrow H^+\ (aq.) + NO_3^-(aq.)$$

Nitric acid Hydrogen ion Nitrate ion

CLASSIFICATION OF ACIDS –

(i) On the basis of their source acids are of two types -

(i) Mineral acids; (ii) Organic acids

(i) Mineral Acids (Inorganic acids):-

The acids which are usually obtained from minerals are known as inorganic acids.

Hydrochloric acid	HCl	In purification of common salt, in textile industry as bleaching agent, to make **aqua regia.**
Sulphuric acid	H_2SO_4	Commonly used in car batteries, in the manufacture of fertilizers (Ammonium phosphate, Supper phosphate detergents etc, in paints, plastics, drugs)
Nitric acid	HNO_3	Manufacture of artificial silk, in petroleum refining. Uses in the manufacture of explosives (TNT, Nitroglycerine) and fertilizers (Ammonium nitrate, Calcium nitrate, Purification of Au, Ag.
Carbonic acid	H_2CO_3	In soft drinks and lends fizz, In stomach as gastric juice, used in tanning industry
Phosphoric acid	H_3PO_4	Used in antirust paints and in fertilizers

Note: Aqua regia is a mixture of (3 part HCl & part HNO_3) which dissolves even noble metals like Au, pt.

(ii) Organic Acids:-

The acids which are usually obtained from plants and animals are known as organic acids.

Formic acid (HCOOH)	Found in the stings of ants and bees, used in tanning leather, in medicines for treating gout.
Acetic acid (CH_3COOH)	Found in vinegar, used as solvent in the manufacture if dyes and perfumes.
Lactic acid	Responsible for souring of milk in curd
Benzoic acid	Used as a food preservative
Citric acid	Present in lemon, orange and citrus fruits
Tartaric acid	Present in tamarind.

(II) On the Basis of their Basicity:-

"The basicity of an acid is the number of replaceable hydrogen atoms present in a molecule that can be produced by the complete ionization of one molecule of that acid in aqueous solution."

Or

"Basicity of an acid is determined by number of hydronium ions ($H_3O^+/H^+(aq)$ produced per molecule of an acid in ionization."

(i) Monobasic Acids:-

The acid on complete ionization produce one hydronium ion in aqueous solution.

Example: Hydrochloric acid(HCl)
Hydrobromic acid (HBr)
Hydrofluoric acid (HF)
Hydriodic acid (HI)
Nitric acid (HNO_3)
Acetic acid (CH_3 COOH)
Formic acid (HCOOH)

$HCl + H_2O \rightleftharpoons H_3O^{\oplus} + Cl^-$ (Chloride ion)
Hydronium ion

$CH_3COOH + H_2O \rightleftharpoons H_3O^{\oplus} + CH_3COO^-$
Hydronium ion Acetate ion

$HNO_3 + H_2O \rightleftharpoons H_3O^{\oplus} + NO^-_3$
Hydronium ion Nitrate ion

(ii) Dibasic Acid:-

The acid on complete ionization produces two hydronium in aqueous solution.

Example: Sulphuric acid (H_2SO_4)
Carbonic acid (H_2CO_3)
Oxalic acid $(COOH)_2$

$H_2SO_4 + H_2O \rightleftharpoons \oplus H_3O + HSO^-_4$ (Step – I)
Bisulphate ion

$HSO^-_4 + H_2O \rightleftharpoons \oplus H_3O + SO_4^{2-}$ (Step – II)
Sulphate ion

(iii) Tribasic Acid:-

The acid on complete ionisation produces three hydronium ions in aqueous solution.

Example:

$H_3PO_4 + 3H_2O \rightleftharpoons 3H_3O + \overset{\oplus}{PO_4}^{3-}$

Hydronium ion Phosphate ion

(III) Classification on the basis of their strength:-

(i) Strong Acid:-

The acid which undergoes complete ionisation in aqueous solution is known as strong acids.

Example:

$HCL + Water \longrightarrow H^+(aq) + Cl^-(aq)$

$H_2SO_4 + Water \longrightarrow 2H^+(aq) + SO_4^{2-}(aq)$

$HNO_3 + Water \longrightarrow H^+(aq) + NO_3^-(aq)$

} Complete ionized

(ii) Weak Acid:-

The acid which undergoes partial or incomplete ionisation in aqueous solution is known as weak acids.

$CH_3COOH + Water \longrightarrow CH_3COO^-(aq) + H^+(aq)$

Acetic acid Acetate ion

Example: Formic acid ($HCOOH$), Oxalic acid $(COOH)_2$

carbonic acid (H_2CO_3), phosphoric acid (H_3PO_4)

(IV) Classification of the concentration of the Acid:-

(i) Concentrated Acid:-

The acid which contains very small amount of water is called a concentrated acid.

(ii) Dilute Acid:-

The acid which contains more amount of water is called a dilute acid.

♣ "Strength of an acid is not depending upon the concentration of an acid"

Strength on acid $\propto$ Concentration of hydronium ion.

BASES –

Substance with bitter taste and give a soapy touch are known as bases but many bases have corrosive nature.

So bases are defined as "

- **According to Arrhenius:**

Those substance which give hydroxide or hydroxyl ion (OH^-) in their aqueous solution" are called bases.

$NaOH(aq.) \rightarrow Na^+ OH^-(aq)$

$KOH(aq.) \rightarrow K^+(aq) + OH^-(aq)$

Example – Sodium hydroxide (NaOH), Zinc oxide (ZnO), Copper oxide (CuO),Calcium hydroxide $[Ca(OH)_2$, Aluminium hydroxide $[Al(OH)_3]$.

The compounds which are either metallic oxides or metallic hydroxides. Which combines with acids to from salts and water only?

$CuO + 2HCl \longrightarrow CuCl_2 + H_2O$

Base Acid Salt Water

$NaOH + HCl \longrightarrow NaCl + H_2O$

Base Acid Salt Water

$Mg(OH)_2 + H_2SO_4 \longrightarrow MgSO_4 + 2H_2O$

Base Acid Salt Water

Alkalis –

A base which completely dissolves in water is called alkalis.

Example – KOH, NaOH, Ca $(OH)_2$

♣ **all the alkalis are bases but all basses are not alkalis.**

Example – $[Fe(OH)_3]$ ferric hydroxide and cupric hydroxide $[Cu(OH)_2]$ are bases, but not an alkali.

CLASSIFICATION OF BASES –

(I) Classification on the basis of their strength:-

(i) Strong alkalis or bases:-

The alkalis or bases which undergo almost complete ionisation in aqueous solution are known as strong alkalis or bases.

Example –

$NaOH(aq.) \longrightarrow Na^+(aq) + OH^-(aq)$

Sodium hydroxide

$KOH(aq) \longrightarrow K^+(aq) + OH^-(aq)$

Potassium hydroxide

$Ba(OH)_2(aq.) \longrightarrow Ba^+(aq) + 2OH^-(aq)$

Barium hydroxide

} Complete ionisation

(ii) Weak alkalis or bases:-

The alkalis or which undergo only partial ionisation in aqueous solution are known as weak alkalis or bases.

Example –

$Ca(OH)_2(aq.) \rightleftharpoons Ca^{2+}(aq) + 2OH^-(aq.)$

Calcium hydroxide

$Mg(OH)_2(aq.) \rightleftharpoons Mg^{2+}(aq) + 2OH^-(aq.)$

Magnesium hydroxide

} Partial ionisation

(II) Classification on the basis their concentration -

(i) Concentrated Bases or Alkali -

The bases or alkalis which contain very small amount of water is called a concentrated bases or alkalis

(ii) Dilute Acid -

The bases or alkalis which contain more amount of water are called dilute bases of alkalis.

(III) Classification on the basis of their acidity -

Acidity of bases is determined by the number of hydroxyl (OH^-) ions produced by per molecule of Bases or Alkali on complete dissociation in water "or"

The 'number of hydrogen ions of an acid with which a molecule of that alkali or react to produce salt and water is known as acidity of an alkali or Bases".

(I) Mono acidic Bases or Alkali -

The base or alkali on complete ionisation produce hydroxyl (OH^-) ion in aqueous solution.

Example – $NaOH(aq.) \longrightarrow Na^+(aq) + OH^-(aq)$

Hydroxyl ion

$KOH(aq.) \longrightarrow K^+(aq) + OH^-(aq)$

Hydroxyl ion

(ii) Diacidic Bases (or alkalis)-

The bases or alkali on complete ionisation produce two hydroxyl ion (OH^-)in aqueous solution

Example –

(A) Diacidic Bases of -

$Ca(OH)_2(aq.)$ $Ca^{2+}(aq.) + 2OH^-(aq.)$

$Mg(OH)_2(aq.)$ $Mg^{2+}(aq.) + 2OH^-(aq.)$

(B) Diacidic Bases -

Ferrous hydroxide [$Fe(OH)_2$] and copper hydroxide [$Cu(OH)_2$]

$Fe(OH)_2(aq.)$ $Fe^{2+} + 2OH^-(aq.)$

$Fe^{+2}(OH)_2^- + 2HCl^-(aq.)$ $FeCl_2 + 2H_2O$

(iii) Tri Acidic Bases -

The base or alkali on complete ionisation produce three hydroxyl ion (OH^-) in aqueous solution.

Example - Aluminum hydroxide [$Al(OH)_3$] Ferric hydroxide [$Fe(OH)_3$]

$Al(OH)_3(aq.)$ $Al^{3+}(aq.) + 3OH^-(aq.)$

$Al^{3+}(OH)_3^- + 3HCl(aq.)$ $AlCl_3 + 3H_2o$

PROPERTIES OF ACID OF AND BASES –

(1) Physical properties of Acid -

(I) Test – Acids have sour test.

(II) Physical state – Some acid are solid while other liquid at room temperature.

Example - Solid - Oxalic acid ($COOH)_2$, Boric acid (H_3BO_3)

Liquid - Acetic acid (CH_3COOH), Formic acid (HCOOH), Sulphuric acid (H_2SO_4)

Volatile liquid - Carbonic acid (H_2CO_3), Hydrochloric acid (HCl) Nitric acid (HNO_3)

(III) Effect of Indicator -

They affect the indicators as given below

Blue litmus paper	Blue to Red
Methyl orange	Orange to Pink
Phenolphthalein	Remains colourless
Turmeric paper	Remains colourless

♣ **C**arbonic acid (H_2CO_3) turns blue litmus to pink. Because this is weak mineral acid

♣ **Litmus –** A water soluble purple dye, extracted from certain lichens, a plant belonging to the division thallophyta and is commonly used as an indicator. The pH range for litmus is 4.5- 8.3 at room temperature.

Ques. You have been providing with three test tubes. One of the contains distilled water and the other two contents an acidic solution and basis solution, respectively. If you are give red litmus paper, how will you identify the contents of each test tube?

[NCERT]

Activity: Take small amount of finely chopped onions along with some strips of clean cloth in a plastic bag. Tie up the bag tightly and leave it as such in a refrigerator for a night. In the morning, take two these strips and check their odour. Now put a few drops of dilute HCl solution on one strip and a few drops of dilute NaOH solution on the other. Rinses both the cloth strips with water and again check their odour and note down in your note book. You will repeat the activity by taking give different odour in HCl and NaOH.

You can repeat the activity by taking dilute vanilla essence. Smells dilute vanilla essence. Now take some dilute HCl solution in one test tube and dilute NaOH solution in another test tube add a few drops of dilute vanilla essence to both the test tubes and shake well. Check the odour once again. You will feel different smells in both the test tubes.

Lastly, you can repeat the activity by taking clove oil place vanilla essence.

From this activity, we conclude that vanilla, onion of clove oil can also be used as olfactory indicators since these change their odour in acidic and basis media.

(IV) Effect on Skin – All strong mineral acids has a corrosive action on skin and cause painful burns.

Example - Concentrated sulphuric acid stains the skin black.

Concentrated nitric acid & hydrochloric acid stains the skin yellow.

(V) Electrical Conductivity – All mineral acids are good conductors of electricity and conduct electricity in their aqueous solution. On electrolysis, they decompose liberating hydrogen at cathode.

(2) Chemical Properties of Acids-

(I) Reaction with metal –

Dilute acids like hydrochloric acid (HCl), sulphuric acid (H_2SO_4) react with certain active metal to evolve hydrogen gas and form their metallic salt

$$Zn(s) + \underset{\text{dilute}}{H_2SO_4} \longrightarrow ZnSO_4\,(aq) + H_2(g)$$

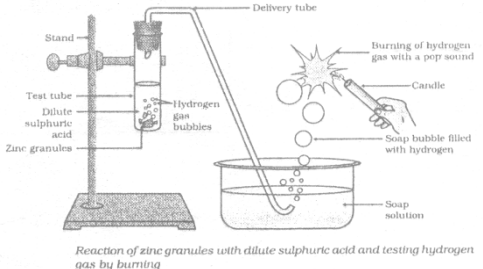
$$2Na(s) + \underset{\text{dilute}}{2HCl} \longrightarrow 2NaCl\,(aq) + H_2\,(g)$$

$$Mg(s) + \underset{\text{dilute}}{H_2SO_4} \longrightarrow MgSO_4\,(aq) + H_2\,(g)$$

$$Fe(s) + \underset{\text{dilute}}{H_2SO_4} \longrightarrow FeSO_4\,(aq) + H_2\,(g)$$

Activity: The study the reaction of acids, with metals.

- **Materials required:-** Granulated zinc, Dilute sulphuric acid, Boiling tube, Matchbox
- **Procedure:-** Take about 5 ml of dilute sulphuric acid in a boiling tube. Add a few piece of zinc metal into it and place an inverted boiling tube over its mouth. You can see the bubbles of hydrogen gas coming out of the mixture in the lower tube. After a few minutes, remove the upper boiling tube (Keeping its mouth downwards) near to its mouth. What do you see? The gas in the upper boiling tube burn with a blue flame producing popping sound. Repeat similar experiment with different acids and few other metals. Write down your observations.



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

- **Observation:** Colourless, odourless gas is evolved. It burns explosively with a 'pop' sound.

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

- **Conclusion:** Reactive metal react with dilute acid to liberate hydrogen gas.
  - ♣ Metals which can displace hydrogen from dilute acid are known as active metals.
    e.g. – Na, K, Zn, Fr, Ca, Mg etc.

Q. Why should curd and sour substance not kept in brass and copper vessels? **[NCERT]**

Q. Which gas is usually liberated when an acid reacts with a metal? Illustrate with an example. How will you test for the presence of this gas? **[NCERT]**

Q. Write word equation and then balance equation for the reaction taking place when –
(a) dilute sulphuric acid reacts with zinc granules **[NCERT]**
(b) dilute hydrochloric acid reacts with magnesium ribbon
(c) dilute sulphuric acid reacts with aluminium powder
(d) dilute hydrochloric acid reacts with iron filings.

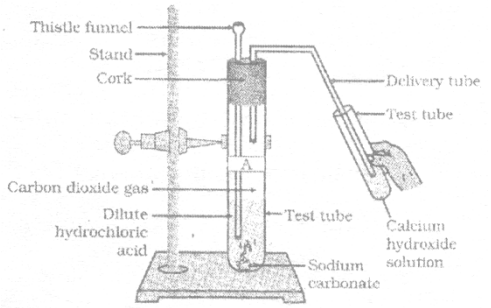
Q. Equal lengths of magnesium ribbons are taken in test tubes A and B Hydrochloric acid (HCl) is added to test tube A, while acetic acid (CH_3COOH) is added to test tube B. Amount and concentration taken for both the acids are same. In which test tube will the fizzing occur more vigorously and why? **[NCERT]**

(II) Reaction with metal carbonates and metal Hydrogen Carbonates -

Both metal carbonates and hydrogen carbonates (bicarbonates) reacts with dilute acids to evolve CO_2 gas and form salt.

Activity: To study the reaction of sodium carbonates and sodium hydrogen carbonate with dilute acids.

- **Materials required:** Sodium carbonate (Na_2CO_3), Sodium hydrogencarbonate, Hydrochloric acid (dil.), Limewater, Boiling tubes, Delivery tube.
- **Procedure:** Take about 0.5g of sodium carbonate in a boiling tube, and 2-3 mL of freshly prepared limewater in another test tube. Set a delivery tube as shown in fig. given alongside. Add about 2mL of dilute hydrochloric acid into the boiling tube containing sodium Carbonate. A brisk effervescence is seen in the reaction mixture. Pass the gas evolved through limewater with the help of a delivery tube. What do you observe? The limewater turns milky. When excess of carbon dioxide is passed, the milkiness disappears. Repeat similar experiment with sodium hydrogencarbonate ($NaHCO_3$), and if desired with other acids also.



Reaction of hydrochloric acid with sodium carbonate Hydrogencarbonates with the liberation of carbon

- **Conclusion:** All acids decompose carbonates and dioxide gas. (Washing soda) and testing the gas evolved

Q. Metal compound A reacts with dilute hydrochloric acid to produce effervescence. The gas evolved extinguishes a burning candle. Write balance chemical equation for the reaction if one compounds formed is calcium chloride. **[NCERT]**

$CaCO_3(s) + 2HCl \longrightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)\uparrow$
Calcium carbonate Dilute Calcium chloride'

$Ca(HCO_3)_2(s) + 2HCl \longrightarrow CaCl_2(aq) + 2H_2O(l) + 2CO_2(g)\uparrow$
Calcium hydrogen Carbonate Dilute

$K_2CO_3(s) + 2HCl \longrightarrow 2KCl(aq) + H_2O(l) + CO_2(g)\uparrow$
Potassium carbonate Dilute Potassium chloride

$KHCO_3(s) + HCl \longrightarrow KCl(aq) + H_2O(l) + CO_2(g)\uparrow$
Potassium hydrogen Carbonate Dilute

$Na_2CO_3(s)$ + 2HCl ⟶ 2NaCl(aq) + $H_2O(l)$ + $CO_2(g)\uparrow$
Sodium carbonate Sodium chloride
$NaHCO_3(s)$ + HCl ⟶ NaCl(aq) + $H_2O(l)$ + $CO_2(g)\uparrow$
Sodium hydrogen
Carbonate

(III) Reaction with metallic oxide -

Metal oxides react with dilute acids to from salt and water.

Activity: To study the reaction of dilute acid with metal oxides (or basis oxides.)

- **Materials required:** Copper (II) oxide. Dilute hydrochloric acid. Test tube
- **Procedure:** Take about 0.5g of copper (II) oxide (black in colour) in a test tube. Add dilute hydrochloric acid dropwise with occasional shaking till copper (II) oxide dissolve. Note the colour of the solution. I not it bluing – green? It is the solution of copper (II) chloride.

- **Conclusion:** Acids reacts with metal oxide to give the corresponding salt & water.

$Na_2O(s)$ + $2HNO_3$ ⟶ $2NaNO_3(aq)$ + $H_2O(l)$
Sodium oxide Dilute Sodium Nitrate
CuO (s) + 2HCl ⟶ $CuCl_2$(aq) + $H_2O(l)$
Copper (II) oxide Dilute Copper(II) chloride
PbO (s) + $2HNO_3$ ⟶ $Pb(NO_3)_2$(aq) + $H_2O(l)$
Lead (II) oxide Dilute Lead (II) Nitrate
FeO (s) + 2HCl ⟶ $FeCl_2$(aq) + $H_2O(l)$
Iron (II) oxide Dilute Iron (II) chloride

(IV) Reaction with metallic sulphites and hydrogen sulphites –

Metallic sulphites and hydrogen sulphites react with dilute acids liberate sulphur dioxide.

$CaSO_3(s)$ + H_2SO_4 ⟶ $CaSO_4$(aq) + $H_2O(l)$
Calcium sulphate Dilute
$NaHSO_3(s)$ + HCl ⟶ NaCl(aq) + $H_2O(l)$
Sodium hydrogen Dilute
Sulphate

(V) Reaction with metallic sulphides and hydrogen sulphides -

Metallic sulphides and hydrogen sulphides react with dilute acid to liberate hydrogen sulphide gas.

FeS + H_2SO_4 ⟶ $FeSO_4$(aq) + $H_2S(g)$
Iron (II) sulphide Dilute Iron sulphate
KHS + HCl ⟶ KCl(aq) + $H_2S(g)$
Potassium Dilute Potassium chloride
Hydrogen sulphide
ZnS + H_2SO_4 ⟶ $ZnSO_4$(aq) + $H_2S(g)$
Zinc sulphide Dilute Zinc sulphate

(VI) Reaction with metal chlorides -

Metal chloride reacts with concentrated acids to produce hydrogen chloride gas. Which give white dense fumes with ammonia.

$2NaCl\ (s) + \text{conc. } H_2SO_4 \xrightarrow{\Delta} Na_2SO_4(aq) + 2HCl(g)$

Sodium chloride — Sodium sulphate

$2KCl\ (s) + \text{conc. } H_2SO_4 \xrightarrow{\Delta} K_2SO_4\ (aq) + 2HCl(g)$

Potassium chloride — Potassium sulphate

(VII) Reaction with metal nitrates -

Metal nitrate react with concentrated acids to produce more volatile nitric acid.

$2NaNO_3 + \text{conc. } H_2sSO_4 \xrightarrow{\Delta} Na_2SO_4\ (aq) + 2HNO_3$

Sodium nitrate

(VIII) Reaction of Acid and Base with each other -

All metallic hydroxides (Bases) react with acids to from their metallic salt and water. This reaction is also known as acid- base neutralization reaction.

Activity: To study a reaction of acid says hydrochloric acid with an alkali or base.

- **Materials required:** Hydrochloric acid solution hydroxide solution, phenolphthalein indicator, Boiling tube, dropper, trough.
- **Procedure:** Take about 5 mL of dilute solution of sodium hydroxide (NaOH) in a test tube. Add 2 drops of phenolphthalein indicator in it. The solution in the test tube turns pink. Now, add dilute solution of hydrochloric acid (HCl) when the pink colour of the solution just disappears.

  Now, add a drops of sodium hydroxide solution and shake the test tube to mix the solution What do you see? The solution turns pink. Add a drop of HCl solution to the solution in the test tube. The pink colour disappears. Keep repeating the addition of sodium hydroxide and hydrochloric acid solution one after the other and water the appearance and disappearance of pink colour.
- Conclusion: This experiment shows that the addition of HCl solution destroys the alkaline nature of NaOH. On the other hand, the addition of NaOH solution destroys the acidic nature of HCl. That is, both NaOH and appears to cancel the effect of each other. Such a reaction between an acid and alkali is called neutralization.

Q. What is a neutralization reaction? Give two examples. **[NCERT]**

$KOH(aq)$	+	HCl	⟶	$KCl(aq)$	+	$H_2O(l)$
Potassium hydroxide		Dilute		Potassium chloride		
$NaOH(aq)$	+	HCl	⟶	$NaCl\ (aq)$	+	$H_2O(l)$
Sodium hydroxide		Dilute		Sodium chloride		
$Ca(OH)_2\ (aq)$	+	$2HNO_3$	⟶	$Ca(NO_3)_2\ (aq)$	+	$2H_2O(l)$
Calcium hydroxide		Dilute		Calcium nitrate		
$Mg(OH)_2\ (s)$	+	H_2SO_4	⟶	$MgSO_4$	+	$2H_2O(l)$
Magnesium hydroxide		Dilute		Magnesium sulphate		
$Cu(OH)_2\ (s)$	+	$2HNO_3$	⟶	$Cu(NO_3)_2\ (aq)$	+	$2H_2)\ (l)$
Copper hydroxide		Dilute		Copper(II) nitrate		

Physical Properties of Bases –

(I) **Taste -** They are sharp bitter in taste.

(II) **Effect on skin -** They give a feeling of soapy touch and all alkali a mild corrosive action on skin.

(III) **Effect on Indictor -** They effect the indicators as give below -

Indictor	**Change in acidic medium**
Red Litmus	Red to Blue
Methyl orange	Orange to yellow
Phenolphthalein	Colourless to Pink
Turmeric paper	Yellow to red brown

(4) **Chemical Properties of Bases -**

(I) **Reaction with Metals –**

Bases react with some metals to liberate hydrogen gas.

$Zn\ (s)$	+	$2NaOH$	⟶	$Na_2ZnO_2\ (aq)$	+	$H_2\ (g)\uparrow$
Zinc		Dilute		Sodium zincate		Hydrogen gas
$2AL\ (s)$	+	$2NaOH+2H_2O(l)$	⟶	$2NaAlO_2$	+	$3H_2\ (g)\uparrow$
Dilute		Sodium aluminate				

(II) **Reaction of bases with Non-metallic oxide -**

Bases react with non-metallic oxide their respective carbonate and water.

$2NaOH\ (aq)$	+	$CO_2(g)$	⟶	$Na_2CO_3\ (aq)$	+	$H_2O\ (l)$
Sodium hydroxide		Carbonate dioxide		sodium carbonate		Water
$2KOH\ (aq)$	+	$CO_2(g)$	⟶	$K_2CO_3\ (aq)$	+	$H_2O(l)$
Potassium hydroxide				Potassium carbonate		

♣ Some of the alkalis like sodium hydroxide (NaOH) are called **deliquescence** because they absorbs carbon dioxide from the air and its strength decreases with time.

(III) Reaction of Bases with Acids -

They neutralize the acids to from salt and water.

Acid + Base → Salt + Water

(IV) Reaction of Bases with ammonium salt -

Bases react with ammonium salt to evolve ammonia gas.

$NaOH\ (aq) + NH_4Cl(g) \longrightarrow NaCl\ (aq) + H_2O\ (l) + NH_3\ (g)\uparrow$

Sodium hydroxide — Sodium chloride

$Ca(OH)_2(aq) + 2NH_4Cl(g) \longrightarrow CaCl_2\ (aq) + 2H_2O\ (l) + NH_3\ (g)\uparrow$

Calcium hydroxide — Calcium chloride

(V) Reaction of Bases with Salt -

Bases react with salt solution to from another base and another salt.

$3NaOH\ (aq) + FeCl_3(aq) \longrightarrow Fe(OH)_3\ (aq) + 3NaCl(aq)$

Sodium hydroxide — Iron (III) chloride — Iron (III) hydroxide

Bases-1 — Salt-1 — Base-2 (Brown ppt.) Salt-2

$2NaOH\ (aq) + ZnSO_4(aq) \longrightarrow Zn(OH)_2\ (s) + Na_2SO_4(aq)$

Sodium hydroxide — Zinc sulphate — Zinc hydroxide (White ppt.) — Sodium sulphate

User of Bases or-

S.No.	Base	Use
	Sodium hydroxide (NaOH)	It is used in the manufacture of washing soap, paper, petrol refining and as a reagent in the laboratory.
2	Potassium hydroxide (KOH)	It is used in the manufacture of soap paper (bathing soap) and alkaline batteries.
3.	Calcium hydroxide (Slaked lime) $[Ca(OH)_2]$	It is used in the manufacture of bleaching powder and softening of hard water.
4	Magnesium hydroxide $[Mg(OH)_2]$	It is used as an antacid.
5.	Aluminium hydroxide $[Al(OH)_3]$	It is used as a foaming agent in fire extinguishers.
6	Ammonium hydroxide (NH_4OH)	It is used in removing grease stains from clothes
7	Sodium carbonate (Na_2CO_3)	It is used as a cleaning agent for domestic purposes and also for removing permanent hardness of water.

Compares Between Properties of ACIDS & BASES –

	Acids		Bases
(i)	Sour in taste	(i)	Bitter in taste
(ii)	The properties are due to the presence of hydrogen ion (H^+) in water solution of an acid	(ii)	The properties are due to the presence of hydrogen ion (OH^-) in water solution of a base.
(iii)	Turns blue litmus to red	(iii)	Turns red litmus to blue
(iv)	Aqueous solution conducts electricity	(iv)	Aqueous solution conducts electricity
(v)	Reacts with active metals like Na, K, Ca and Zn to give hydrogen gas.	(v)	Does not react with metal except with Zn, Al and Sn.
(vi)	Acidic properties disappear when react with bases (Neutralization)	(vi)	Basis properties disappears when react with acids (Neutralization)
(vii)	Reacts with carbonate to give carbon dioxide	(vii)	Absorbs carbon dioxide to from carbonate.
(viii)	Frequently corrosive to skin	(viii)	Frequently corrosive to skin and slippery in nature.
(ix)	The pH value is less than 7 at 25^oC	(ix)	The pH value is greater than 7 at 25^oC

WHAT SO ALL ACIDS AND BASES HAVE IN COMMON?

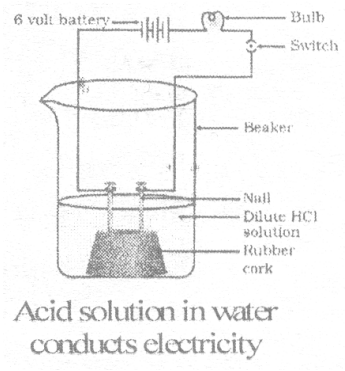
A common thing for all the acids that they produce hydrogen ions [H^+ (aq.)] when dissolved in water.

For Example – Acids like HCl, H_2SO_4, HNO_3, CH_3COOH etc. show acidic character because they dissociate in aqueous solution produce hydrogen ions.

But all the compounds containing hydrogen are not acids such glucose ($C_6H_{12}O_6$) and alcohol (C_2H_5OH) also contain hydrogen but they do not show acidic character.

Activity: To find the characteristics common between acids and bases.

- **Materials required:** Dilute hydrochloric acid, Dilute sulphuric acid, Dilute solution of sodium hydroxide, Ethanol, Glucose solution & Beaker, Carbon electricity, Dry cells, bulb 1.5 V, Key.
- **Procedure:** Take a beaker and place two carbon electrodes into it. Connect the electrodes to a battery bulb though a key and a dry cell. Pour dilute hydrochloric acid into the beaker and press the key. Did the bulb glow? Perform similar experiment with the give solution, and record your observation



Acid solution in water conducts electricity

- **Observation:**

Solution	Bulb glows	Bulb does not glow	Nature of solution
Dil. Hydrochloric acid	✔	✘	Conducting
Dil Sulphuric acid	✔	✘	Conducting
Dil. Sodium hydroxide	✔	✘	Conducting
Ethanol	✘	✔	Non- Conducting
Glucose solution	✘	✔	Non- Conducting

- **Conclusion:** The solution of acids and bases are good conductors of electricity. The solution of glucose and ethanol are nonconductor of electricity.

A common thing for all the bases (or) is that all produce hydroxide ions (OH^-) when dissolved in water.

For Example – NaOH, $Mg(OH)_2$,$Ca(OH)_2$ and NH_4OH are all bases because they dissolve in water to produce hydroxide ion (OH^-)

Q. Why do HCl, HNO_3, etc show acidic characters in aqueous solution while solution of compounds like alcohol and glucose do not show acidic characters? **[NCERT]**

Q. Why does an aqueous solution of acid conduct electricity? **[NCERT]**

Q. Compounds such as alcohol and glucose also contain hydrogen are not categorized as acids. Describe an Activity to prove it.

ACIDS OR BASES (ALKALI) IN WATER SOLUTION –

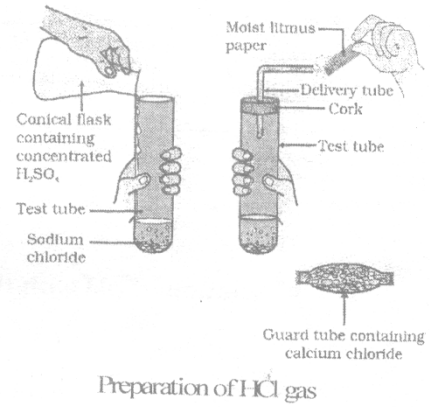
The acidic behaviour of acids due to the presence of hydrogen ions. H^+(aq) ions, in them. The acids produce hydrogen ions only in the presence of water. So, in the absence of water, a substance will not form hydrogen ions and hence will not show its acidic behaviour.

Q. Why does dry HCl gas not change the colour of the dry litmus paper? **[NCERT]**

Q. Why does distilled water not conduct electricity, whereas rain does? **[NCERT]**

Q. Why do acids not show acidic behaviour in the absence of water? **[NCERT]**

Activity: To show that acids furnish H^+ (aq) ions only in the presence of water.



Preparation of HCl gas

● **Materials required:** Common salt, Conc. Sulphuric acid, anhydrous calcium chloride, blue litmus paper, boiling tube, delivery tube packed with anhydrous calcium chloride.

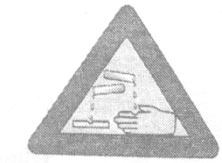
● **Procedure:** Take 0.5g of dry common salt in a dry boiling tube. Add a few drops of concentrated sulphuric acid over common salt in the boiling tube. What do you see? A colourless, irritating gas is evolved. Fit a cork carrying a calcium chloride packed delivery tube into the mouth of the boiling tube.

Bring a dry blue litmus paper near the opening if the calcium chloride tube. Observe, if there is any changes in colour. Colour of the litmus paper remains unchanged. Now, bring a moist blue litmus paper near the mouth of the calcium chloride tube. Do you observe any change in the colour of litmus paper? Yes, blue litmus has changed to red. Form the above activity, following conclusion can be drawn:-

● **Conclusion:** Dry HCl gas on coming in contact with blue litmus paper does not produce H^+ ions and hence the colour of litmus paper does not change. So, we say that separation of H^+ ions from acid takes place only in the presence of water.

Important Point – Why should water be never added to dilution of an Acid? **Ans.** Mixing of water in acid is an exothermic process and more heat is produced that splashing of water. In order to avoid this. We must add acid into water and not water into acid.

Moreover, of water also be added to water in small lost and not in one installment.


Warning Sign displayed on containers containing concentrated acids and bases

HOW STRONG ARE ACID OR BASE SOLUTION –

Acids and bases on dilution with water, decreases the concentration of $H^+(aq)$ or $OH^-(aq)$ ions the acidic and basis solution respectively.

If we find quantitatively, the amount of $H^+(aq)$ / $OH^-(aq)$ ions present in a solution, we can judge how strong an acid or a base is?

We can do this by the help of a universal indicator, which is a mixture of several indicators. The universal indicator shows different colours at different concentration of hydrogen ions or pH values in solution.

Q. When diluting an acid, why is it recommended that the acid should be added to water and not water to the acid? **[NCERT]**

Q. How is the concentration of hydronium ions (H_3O^+) affected when a solution of an acid is diluted? **[NCERT]**

Q. How is the concentration of hydroxide ions (OH^-) affected when excess base is dissolved in a solution of sodium hydroxide? **[NCERT]**

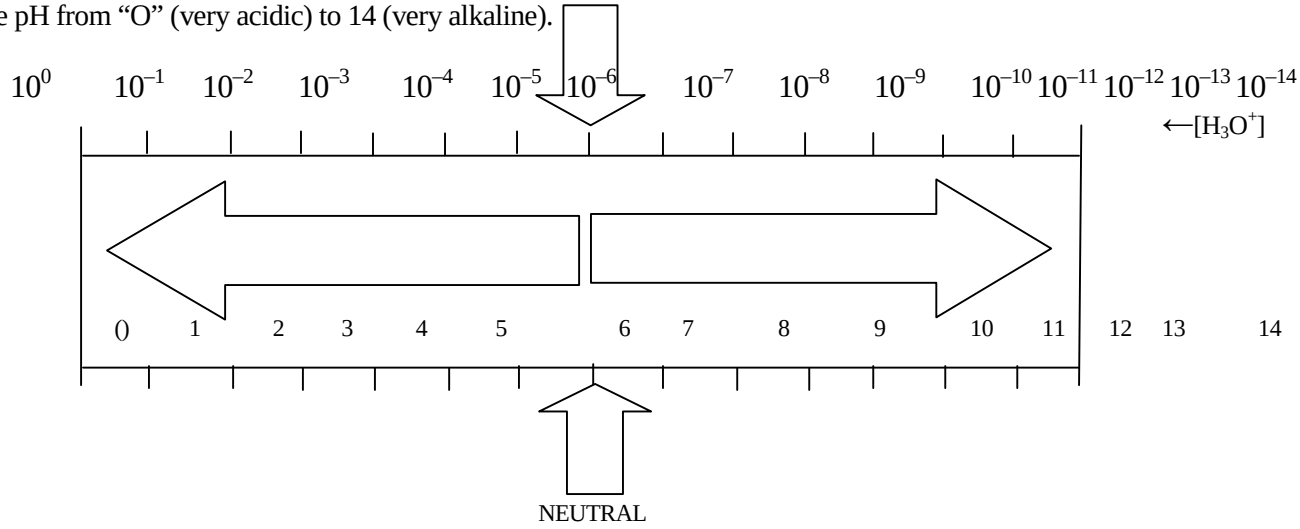
Q. You have two solutions, A and B. The pH of solution A is 6 and pH of solution B is 8. Which solution has more hydrogen ion concentration? Which of this is acidic and which one is basic? **[NCERT]**

Q. What effect does the concentration of H^+ (aq) ions have on the nature if the solution? **[NCERT]**

Q. Do basis solution also have $H^+(aq)$ ions? If yes, than why are these basis? **[NCERT]**

SCALE –

S.P.L. Sorenson, a Danish Chemist in 1909 introduced the concept of measuring the concentration of hydrogen ions (H^+(aq)) in a particular solution., The p in pH stands for 'potenz' in German, meaning power. On the pH scale we can measure pH from "O" (very acidic) to 14 (very alkaline).



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

The concentration of H^+ (aq) and OH^- (aq) ions in pure water is $1x10^{-7}$ mol $litre^{-1}$. This means that all aqueous solution contain both H^+(aq) and OH^-(aq) ions. The product of concentration of H^+(aq) and OH^- (aq) in water is constant (equal to $1x10^{-14}$ mol^2 $litre^{-2}$ at 25 ^oC) and is known as ionic product of water (K_w).

$K_w = [H^+(aq)]\,[OH^-(aq)]$

$= (1x10^{-7})\,(1x10^{-7}) = 1x10^{-14}$ mol^2 at 25 ^oC

- If $[H^+(aq)] = [OH^-(aq)] = 1x10^{-7}$ mol $litre^{-1}$, then the solution is neutral.
- if $H^+(aq) > OH^-$ (aq)
  (H^+ (aq) > $1x10^{-7}$ mol $litre^{-1}$), then the solution should be acidic
- and if $H^+(aq) < OH^-(aq)$ or
  $H^+(aq) < 1x10^{-7}$ mol $litre^{-1}$, then the solution should be basis or alkaline.

Table – pH Value of Some Common Substances

Solution	pH Value	Solution	pH value
Conc. Hydrochloric acid	0	Dil. Hydrochloric acid	1.0
Conc. Sodium hydroxide	14.0	Dil. Sodium hydroxide	13.0
Gastric Juice	1.4	Lemon juice	2.5
Vinegar	4.0	Tomato juice	4.1
Saliva (before meals)	7.4	Saliva (after metals)	5.8
Coffee	5.0	Soft drink	6.0
Blood	7.4	Eggs	7.8
Toothpaste	8.0	Banking Soda Solution	8.5
Washing Soda Solution	9.0	Pure Water	7.0

Q. Five solution A, B, C, D and E when tested with universal indicator showed pH as 4, 1, 11, 7 and 9 respectively. Which solution is - **[NCERT]**
(a) neutral (b) strongly alkaline (c) strongly acidic (d) weakly acidic
(e) weakly alkaline

Q. Fresh milk has a pH of 6. How do you think the pH will changes as it turns into curd? Explain your answer. **[NCERT]**

Q. Why milkman adds a very small amount of baking soda to fresh milk. **[NCERT]**
(a) Why does he shift the pH of the fresh milk from 6 to slightly alkaline?
(b) Why does this milk take a long time to set as curd?

Importance of pH in everyday life –

(1) Plants and Animals are pH Sensitive -

The pH plays an importance role in the survival of animals, including human being. Our body works well within a narrow pH range of 7.0 to 7.8. The aquatic animal (Fish) can survive in river water within a narrow range of pH change.

Example – When the pH rain water is about 5.6. It is called acid rain. Too much acid rain can lower the pH of river water to such an extent and make it so acidic that the survival of aquatic animals become difficult or kill the aquatic animals.

Soil pH and Plants –

Most of the plants grow best when the pH of soil is close to 7. If the soil is too acidic or too basis (too alkaline), the plants grow badly or do not grow at all.

Treatment of Acidic or Basis Soil –

The pH of acidic soil can reach as low as 4 and that of the basis soil can go up 8.3 Chemicals can be added to soil to adjust its pH and make it suitable for growing plants. If the soil is too acidic, then it is treated with materials like quicklime (calcium oxide) or slaked lime (Calcium hydroxide) or chalk (Calcium carbonate). All these materials are bases and hence react with the excess acid present in soil reduce its acidity. If the soil is too basis (or too alkaline) then its alkaline can be reduced by adding decaying organic matter (manure or compost.) This contains acidic materials.

(2) Importance of pH in our digestive system -

As we know our stomach produces gastric juice which contains large amount of hydrochloric acid (pH about 1.4). The acid so produced does not harm the stomach walls, but kills germs and bacteria which enter in our digestive system along with food, thus in a way it protects us from diseases and helps in digestion. Sometimes excess of acid is produced in the stomach due to overeating of eating spicy food. This stage is called acidity. To get relief from this pain, we tablets known as **antacids**. These contain bases to neutralize the excess acids.
Example – Magnesium hydroxide d(milk of magnesia). $Mg(OH)_2$

(3) pH change as the cause of tooth decay -

Generally, the pH in the mouth is more than 7, as the saliva produced in the mouth is basis in nature. However, when we take food, some food particles remain in the mouth after eating and bacteria present in the mouth produce acids by degradation of food particles. This acid lowers the pH in the mouth, tooth decay starts when the pH of acid formed in the mouth falls below 5.5. Therefore to prevent tooth decay. It is advised to clean the mouth and use toothpastes which are generally basic, for cleaning the teeth. It neutralize the excess acid prevent tooth decay.

(4) Self defense by animals and plants through chemical Warfare -

The sting of the honey bee contains formic acid, this acid causes a lot of irritation and pain. The pain can be reduced by applying baking soda paste on the affected region as the acid gets neutralized.

In plant kingdom **nettle** (Bichu Booti) is a herbaceous plant which grows in wild. The nettle leaves have stinging hair. When a person happens to touch the leaves of a nettle plant accidently, the stining hair of nettle leaves inject methanoic acid (HCOOH) into the skin of the person causing burning pain. The nettle sting being acidic can be neutralized by rubbing baking soda on the skin. Nature provides remedy for the nettle sting in the form of a 'dock' plant, which often grows besides the nettle plants. The leaves of dock plant contain some basis chemical which neutralizes methanoic acid.

SALTS

♣ A substance formed by the partial or complete replacement of $H^+(aq)$ ions of an acid by a metal or electropositive ion, is called a salt.

For Example –

$H_2SO_4 + NaOH \longrightarrow NaHSO_4 + H_2O$

Sodium hydrogen sulphate

(Partial replacement: only one hydrogen atoms is replaced)

$H_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2H_2O$

Sodium sulphate

(Complete replacement: Both the hydrogen atom are replaced)

♣ A substance formed by neutralization of an acid with a base is called a salt.

Example - $HCl(aq) + NaOH(aq) \longrightarrow NaCl(aq) + H_2O$

Acid Base Salt Water

♣ A salt is a ionic compound which dissolved in water dissociate to positive ions other than hydrogen ions (H^+) and negative ions other than hydroxyl ions (OH^-) are called salts.

Example - $NaCl + Water \longrightarrow Na^+(aq) + Cl^-(aq)$

$CuSO_4 + Water \longrightarrow Ca^{2+}(aq) + SO_4^{2-}(aq)$

Naming of Salts –

(A) Salt obtained from "Sulphuric acid" are called "Sulphates". **e.g.** Na_2SO_4, $CuSO_4$

(B) Salt obtained from "nitric acid" are called "Nitrates" **e.g.** KNO_3, $NaNO_3$

(C) Salt obtained from "hydrochloric acid" are called "Chlorides" **e.g.** NaCl, $CaCl_2$, KCl

(D) Salt obtained from "phosphoric acid" are called "Phosphates" **e.g.** $Ca_3(PO_4)_2$, Na_3PO_4, $Mg_3(PO_4)_2$

(E) Salt obtained from " carbonate acid" are called "Carbonates" **e.g.** Na_2CO_3, KK_2CO_3, $CaCO_3$,

(F) Salt obtained from acetic are called "Acetates" **e.g.** CH_3COONa, $(CH_3COO)_2Ca$, $CH_3(COO)_2Pb$.

CLASSIFICATION OF SALTS –

The salts may be classified in the following ways –

(1) Normal Salts -

The salts which are obtained by complete replacement of the ionisable hydrogen atoms or hydroxyl ion by a metallic or an ammonium ion are called normal salts

"OR"

A salt that does not contain any replaceable hydrogen atoms or hydroxyl group is called a normal salt.

Example - $HCl + NaOH \longrightarrow NaCl + H_2O$
(Normal salt)
Sodium chloride

$H_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2H_2O$
(Normal salt)
Sodium sulphate

$Pb(OH)Cl + HCl \longrightarrow PbCl_2 + H_2O$

Some normal salt with their parent acids

S.No.	Parent Acids	Normal Salts
1	Hydrochloric acid (HCl)	Na, KCl, $MgCl_2$, $AlCl_3$, $ZnCl_2$, $CaCl_2$ and NH_4Cl
2	Nitric acid (HNO_3)	$NaNO_3$, KNO_3, $Mg(NO_3)_2$, $Al(NO_3)_3$, $Zn(NO_3)_2$, $Ca(NO_3)_2$
3	Sulphuric acid (H_2SO_4)	Na_2SO_4, K_2SO_4, $MgSO_4$, $Al_2(SO_4)_3$, $ZnSO_4$, $CaSO_4$
4	Acetic acid (CH_3COOH)	CH_3COONa, CH_3COOK, $(CH_3COO)_2Ca$, $(CH_3COO)_2Pb$,
5	Carbonic acid (H_2CO_3)	Na_2CO_3, K_2CO_3, $MgCO_3$, $ZnCO_3$, $CaCO_3$, $(NH_4)_2CO_3$
6	Phosphoric acid (H_3PO_4)	Na_3PO_4, K_3PO_4, $Mg_3(po_4)_2$, $Zn_3(PO_4)_2$, $Ca3(PO_4)_2$

(2) Acidic Salts –

The salts which are obtained by the partial replacement of ionisable hydrogen atoms of a polybasic acid by a metal or an ammonium ion are called Acid Salts.

$H_2SO_4 + NaOH \longrightarrow NaHSO_4 + H_2O$
Insufficient amount
Sodium hydrogen Sulphate (acid salt)

$NaHSO_4 \longrightarrow Na^+ + H^+ + SO^{2-}_4$

Some acid salts with their parent acids

S.No.	Parent Acid	Acid salts
1	Sulphuric acid (H_2SO_4)	$NaHSO_4$, $KHSO_4$, $Ca(HSO_4)_2$
2	Carbonic acid (H_2CO_3)	$NaHCO_3$, $KHCO_3$, $Ca(HCO_3)_2$, $Mg(HCO_3)_2$
3	Sulphurous acid (H_2SO_3)	$NaHSO_3$, $KHSO_3$, $Ca(HSO_3)_2$, $Mg(HSO_3)_2$
4	Phosphoric acid (H_3PO_4)	NaH_2PO_4, Na_2HPO_4, KH_2PO_4, K_2HPO_4, $Ca(H_2PO_4)_2$, $CaHPO_4$

(3) Basis Salt –

The salt which are formed by partial replacement of hydroxyl (-OH) groups of a polyacidic base by an acid radial are called basis salts.

$Pb(OH)_2 + HCl \longrightarrow Pb(OH)Cl + H_2O$
Lead hydroxide
Lead oxychloride (Basic salt)

(4) Double salt –

The salt which are obtained by the crystallization of two simple salts, from a mixture of their saturated salt solution are known as double salts.

DO YOU KNOW?

For Example -

(A) Potash alum -

K_2so_4 + $Al_2(SO_4)_3$ + $24H_2O$ $\xrightarrow{Crystallisation}$ $K_2SO_4.Al_2(SO4)_324H_2O$

Potassium sulphate Aluminium sulphate Potash alum (Double salt)

(B) Mohr's Salt – $FeSO_4(NH_4)_2SO_4.{}_6H_2O$

(C) Dolomite - $CaCO_3.MgCO_3$

(D) Carnallite – $KCl.MgCl_2.6H_2O$

(E) Ferric alum - $Fe_2(SO_4)_3.24H_2O$

(5) Mixed Salt -

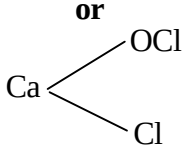
The salts containing more than one cations or anions other than H^+ or OH^- ions are called mixed salts.

For Example –

Sodium Potassium Carbonate – $NaKCO_3$ (contains two cations)

Bleaching powder – $CaOCl_2$ (contains two anions Cl^- and $dOCl^-$)

or



Disodium potassium phosphate - (Na_2KPO_4)

Microcosmic salt - $NaNH_4HPO_4$

General methods of preparation of soluble salts –

(I) By direct combination of element – By heating two element together

2Na + Cl_2 $\xrightarrow{\Delta}$ 2NaCl

Molten Sodium (Metal) Chlorine (non- metal) Sodium chloride

Zn + Cl_2 $\longrightarrow$ $ZnCl_2$

(metal) (non-metal) Zinc chloride

(II) By the action of dilute mineral acids on active metal -

Zn + dil. H_2SO_4 $\longrightarrow$ $ZnSO_4 + H_2(g)$

2Al + dil 6HCl $\longrightarrow$ $2AlCl_3 + 3H_2$ (g)

2Na + dil. 2HCl $\longrightarrow$ $2NaCl + H_2$ (g)

(III) By Decomposition -

(a) By Decomposition of metal hydrogen carbonates -

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

(b) By Decomposition of metal chloride -

$CuCO_3(s)$ + 2HCl (dill) $\longrightarrow$ $CuCl_2$ + H_2O + $CO_2(g)$

Copper carbonate

(c) By decomposition of metal chloride -

$2NaCl + H_2SO_4\ (conc.) \xrightarrow[200^0 C]{\Delta} Na_2SO_4 + 2HCl\ (g)$

Sodium sulphate

(IV) By the process of neutralization -

Acid + Base (alkali) ⟶ Salt + water

HNO_3 + NaOH ⟶ $NaNO_3$ + H_2O

Nitric acid Sodium hydroxide Sodium nitrate

(V) By the action of alkalis on metals-

$Zn + 2NaOH \longrightarrow Na_2ZnO_2 + H_2(g)\uparrow$

Sodium zincate

General methods of preparation of insoluble salts –

(VI) By direct combination of elements -

When metal power is heated with sulphur, we get corresponding metal sulphides which are insoluble salts

Pb + S ⟶ PbS

Lead Sulphur Lead sulphide

(2) By double decomposition of two soluble salt –

Soluble salt (I) + Soluble salt (II) ⟶ Insoluble salt (Precipitate) + Soluble salt

$NaCl$ + $AgNO_3$ ⟶ $AgCl(\downarrow)$ + $NaNO_3$

(Sodium chloride) (Silver nitrate) (Silver chloride) (Sodium nitrate)

$BaCl_2$ + Na_2SO_4 ⟶ $BaSO_4(\downarrow)$ + 2nAcl

(Barium chloride) (Sodium chloride) (Barium sulphate) (Sodium chloride)

$Pb(NO_3)_2$ + $NaSO_4$ ⟶ $PbSO_4(\downarrow)$ + $2NaNO_3$

(Lead nitrate) (Sodium sulphate) (Lead sulphate) (Sodium nitrate)

FAMILY OF SALT –

The salts having the some positive radical (or cation) or negative radical (or anion) are said to belong to the same family. For example,

- NaCl (sodium chloride) and Na_2SO_4 (sodium sulphate) belong to the family of sodium salts because both contain the same radical (or cation), that is Na^+. These may be called sodium salts.
- Copper sulphate ($CuSO_4$) and sodium sulphate (Na_2SO_4) belong to the family of sulphate because both contain the same acid radical (or anion), that is sulphate (SO_4^{2-}).

The salts belong to certain families are listed belong:

Sulphate family	Sodium family	Chloride family
Potassium sulphate (K_2SO_4)	Sodium sulphate (Na_2SO_4)	Sodium chloride (NsCl)
Sodium sulphate (Na_2so_4)	Sodium bromide (NaBr)	Ammonium chloride (NH_4CL)
Magnesium sulphate ($MgSO_4$)	Sodium nitrate ($NaNO_3$)	Calcium chloride ($CaCl_2$)
Calcium sulphate ($CaSO_4$)	Sodium carbonate (Na_2CO_3)	Potassium chloride (KCl)
Copper sulphate ($CuSO_4$)		

pH OF SALT:

Activity:

- Collect the following salt samples – sodium chloride, potassium nitrate, aluminium chloride, zinc sulphate, copper sulphate, sodium acetate, sodium carbonate and sodium hydrogencarbonate.
- Check their solubility in water.
- Check the action of these solution on litmus and find the pH using a pH paper.
- Which of the salts are acidic, basis or neutral?
- Identify the acid or base used to from salt.

S.No.						Salt	
	Salt	**Solubility**	**Action on litmus**	**pH**	**Nature**	**Acid**	**Base**
1	Sodium Chloride	Soluble	No action	7	Neutral	HCl	NaOH
2	Potassium Nitrate	Soluble	No action	7	Neutral	HCl	KOH
3	Aluminium chloride	Soluble	Turns red	Less than 7	Acidic	HCl	$Al(OH)_3$
4	Zinc Sulphate	Soluble	Turns red	Less than 7	Acidic	H_2SO_4	$Zn(OH)_4$
5	Copper sulphate	Soluble	Turns red	Less than 7	Acidic	H_2SO_4	$Cu(OH)_2$
6	Sodium acetate	Soluble	Turns blue	More than 7	Basic	CH_3CO OH	NaOH
7	Sodium Carbonate	Soluble	Turns blue	More than 7	Basic	H_2CO_3	NaOH
8	Sodium Hydrogencarbonate	Soluble	Turns blue	More than 7	Basic	H_2CO_3	NaOH

SODIUM CHLORIDE (COMMON SALT/ TABLE SALT) –

We known that hydrochloride acid and sodium hydroxide combine with each other to form sodium chloride (NaCl) which in common language is also known as common salt. This is the salt which you sprinkle on your salads and use in your kitchens. Common salt is ionic compound of sodium and chlorine $\mathbf{(Na^+Cl^-)_n}$.

The main source of common salt (sodium chloride) is the water. Sea water contains about 3.5% of soluble salts, the most common of which is sodium chloride (2.7 to 2.9%). Saline water of inland lakes, such as Sambhar lake in Rajasthan is also a good source of common salt (sodium chloride) is also found as rock salt. Bads of rock salt were formed when lakes/Seas dried up in past.

CHEMICALS FROM COMMON SALT –

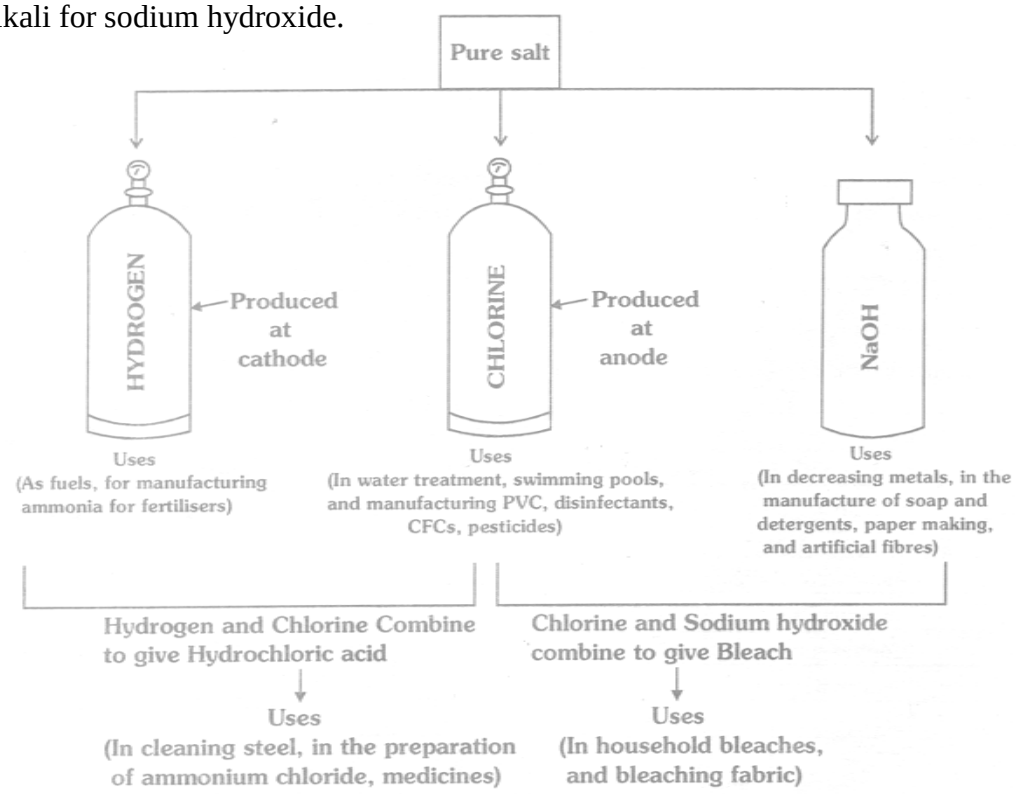
Common salt is a raw material for chemicals and play an important role for making various materials of daily use. Such as sodium hydroxide. Baking soda, washing soda, bleaching power and many more.

(i) Sodium hydroxide:- Commercially, sodium hydroxide is also called **caustic soda** because of its corrosive action on animal and vegetable tissues.

Chlor-alkali process for obtaining sodium hydroxide – When we pass electricity through a solution of sodium chloride, commonly called **brine.** It decomposes to from sodium hydroxide according to the following equation:

$$2NaCl(aq) + 2H_2O(I) \xrightarrow[\text{Current}]{\text{Electric}} 2NaOh(aq) + Cl_2(g) + H_2(g)$$

On electrolysis, chlorine gas is formed at anode and hydrogen at cathode sodium hydroxide solution is formed near the cathode. All these products are commercially important. The process of production of sodium hydroxide from sodium chloride is known as chlor-alkali because of products formed-chlor for chlorine and alkali for sodium hydroxide.



(ii) Bleaching power:-

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

$$Ca(OH)_2 + Cl \longrightarrow CaOCl_2 + H_2O$$

Slaked lime — Bleaching power

Q.	What is the common name of the compound $CaCL_2$?	**[NCERT]**
Q.	Name of the substance which on treatment with chlorine yields bleaching power.	**[NCERT]**

Used of bleaching power

(a) For bleaching cotton and line in the textile industry, for bleaching wood pulp in paper factories and for bleaching washed clothes in laundry.

(b) As an oxidising agent in many chemical industries, and

(c) For disinfecting drinking water to make it free of germs.

(iii) Baking soda:-

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

$NaCl(aq) + H_2O(I) + CO_2(g) + NH_3(g) \longrightarrow NH_4Cl(aq) + NaHCO_3(s)$
Common salt — ammonium Chloride — Sodium hydrogencarbonate

It can be used to neutralize an acid because it is mild non-corrosive base to the hydrolysis of HCO^-_3 ion.
The following reaction takes place when it is heated during cooking.

$$2NaHCO_3(s) \xrightarrow{Heat} Na_2CO_3(s) + H_2O(g) + CO_2(l)$$

Q. What will happen if a solution of sodium hydrogen carbonate is? Give the equation of the reaction involved. **[NCERT]**

Used of sodium hydrogencarbonate ($NaHCO_3$)

(a) For making baking power which is a mixture is a baking soda (sodium hydrogencarbonate) and a mild edible acid like tartaric acid. When power is mixed with water, the following reaction takes place.

$NaHCO_3 + H^+ \longrightarrow CO_2 + H_2O +$ Sodium salt of the acid
(H^+ From acid)

Carbon dioxide so produced during the reaction is responsible for making the bread and cake to rise making them soft and spongy.

(b) As an ingredient in antacids. Being alkaline, it neutralises excess acid in the stomach and provides relief.

(c) It is used in soda- acid fire extinguisher.

(iV) Washing soda (Sodium carbonate):-

The chemical formula of washing soda is $Na_2CO_3.\ 10H_2O$, (sodium carbonate decahydrate). Anhydrous sodium carbonate (Na_2CO_3) is generally called soda ash. Washing soda is manufactured by **Solvay process.** This process is also known as **Ammonia soda process.** The raw needed for the process are sodium chloride, lime stone ($CaCO_3$) and ammonia (NH_3). The reactions involved are.

Step-I $NaCl(aq) + H_2O(I) + CO_2 + NH_3(g) \longrightarrow NH_4Cl(aq) + NaHCO_3(s)$
Common salt — ammonium Chloride — Sodium hydrogencarbonate

The CO_2 requried in this reaction is obtained by heating limestone.

$CaCo_3 \xrightarrow{Heat} CaO + CO_2(g)$
Limestone — quicklime

Step-II Dry sodium hydrogencarbonate is heated strongly to produce sodium carbonate.

$$NaHCO_3(s) \xrightarrow{Heat} Na_2CO_3\ (s) + H_2O(I) + CO_2(g)$$
Sodium carbonate
Soda ash

Step-III Washing soda ($Na_2CO_3\ 10H_2O$) is obtained by crystallization form a saturated solution of soda ash (Na_2CO_3)

$Na_2CO_3(s) + H_2O(I) \longrightarrow Na_2CO_3\ (aq) \xrightarrow{crystallisation} Na_2CO_3\ 10H_2O$
Sodium carbonate — water — washing soda

Q. Name the sodium compound which is used for softening hard water. **[NCERT]**
Q. Give two important uses of washing soda and baking soda. **[NCERT]**

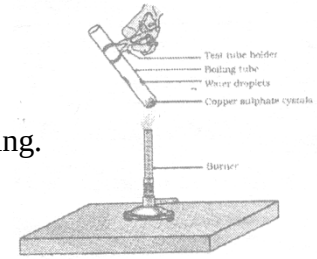
Uses of washing soda:-

(a) Washing soda (or sodium carbonate) is used for washing cloth (laundry purposes).
(b) Washing soda is used for softening hard water.
(c) Sodium carbonate (soda ash) is used for the manufacture of hysrogents.
(d) Sodium carbonate is used for the manufacture of many important compounds, such as borax ($Na_2B_4O_7$), Hypo ($Na_2S_2O_3$. $5H_2O$), etc.
(e) Sodium carbonate is also used in paper and paint industries.

ARE THE CRYSTALS OF SALTS REALLY DRY?

Crystals of some salt contain certain amount of associated water. The water associated the crystal (or molecule) of any salt is called water of **crystallization.**

The salt containing water of crystallization are called **hydrated salts.**



Removing water of crystallisation

Activity:- To show that water of crystallization can be removed by heating.

- **Materials required:-** $CuSO_4$ $5H_2O$ (Blue vitriol), boiling tube, burner, cork, delivery tube, test tube, clamp stand.
- **Procedure:-** Take 2g of $CuSO_4$ $5H_2O$ in a boiling tube fitted in a clamp stand.

Observe its colour. Fit it with cork and delivery tube bent at two right angles which dips into a test tube.

- Heat crystals in boiling tube.
- Observe vapours being condensed in test tube.
- Cool the crystals and add few drops of water into it

- **Observation:** Water vapours get condensed in a test tube and colour of blue crystals changes into white. On adding water to anhydrous copper sulphate it changes into again.

$$\underset{\text{Blue vitriol}}{CuSO_4\ 5H_2O} \xrightarrow{\text{Heat}} \underset{\text{White}}{CuSO_4 + 5H_2O}$$

- **Conclusion:-** Crystalline substance have water of crystallization which is not on heating.

- **Water of crystallization:-** It is fixed number of water molecules present in crystalline salt, eg.

Blue vitriol	$CuSO_4$	+	$5H_2O$	Green vitriol	$FeSO_4$	+	$7H_2O$
Glauber's salt	Na_2SO_4	+	$10H_2O$	White vitriol	$ZnSO_4$	+	$7H_2O$
Gypsum	$CaSO_4$	+	$2H_2O$	Epsom salt	$MgSO_4$	+	$7H_2O$

PLASTER OF PARIS: ($CaSO_4$ $1/2H_2O$)

- Plaster of paris is hemihydrate (hemi means half and hydrate means water) of calcium sulphate. Its molecular formula is $CaSO_4.1/2H_2O$ or $(CaSO_4)_2$. H_2O
- In plaster of paris one molecule water is shared by two $CaSO_4$ as

$CaSO_4$ –H
|
$CaSO_4$-H-O

Preparation of Plaster of paris:

Plaster of paris is obtained by heating gypsum ($CaSO_4.2H_2O$) at 373K(or 100^oC).

$2[CaSO_4.2H_2O](s) \xrightarrow[heat]{373K,(100^0C)} (CaOSO_4)_2\ H_2O(s) + 3H_2O(g)$

gypsum Plaster of paris

or $CaSO_4.\ 2H_2O(s) \xrightarrow[heat]{373K,(100^0C)} CaSO_4.1/2H_2O(s) + 3/2H_2O(g)$

gypsum Plaster of paris

During the preparation of plaster of paris. Temperature should be controlled carefully. Otherwise, anhydrous calcium sulphate ($CaSO_4$) will be formed. Anhydrous calcium sulphate does not set into hard mass when mixed with water. So, if temperature is not controlled carefully, the plaster of paris obtained will have poor setting property.

Q. Write an equation to show the reaction between plaster of paris water. **[NCERT]**

Q. Plaster of paris should be stored in a moisture – proof container. Explain why? **[NCERT]**

Property of Plaster Paris:

- Plaster of paris a white, odourless powder.
- At ordinary room temperature, plaster of paris absorbs water and a large amount of heat is liberated.
- When mixed with a limited amount of water (50% by mass), if forms a plastic mass, evolves heat and quickly sets to a hard porous mass within minutes. This is called the **setting process.**

  During setting, a slight expansion in volume occurs. It is due to this that fit the mould completely and gives sharp impression. The reaction during process is

  $CaSO_4.\ 0.5H_2O(s) + 1.5\ H_2O(l) \longrightarrow CaSO_4.\ 2H_2O(s)$

  Plaster of paris Water Gypsum (Hard mass)

Uses of Plaster of paris:

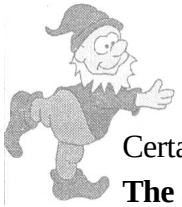
- Plaster of paris is used in marking casts and patterns for moulds and statue.
- Plaster of paris is used as cement in ornamental casting and for making decorative materials.
- Plaster of paris is used as fire proofing material and for making chalks.
- Plaster of paris is used as a fire proofing material and for making chalks.
- Plaster of paris is used in hospitals for immobilizing the affected part in case of bone fracture of strain.
- Plaster of paris (POP) is used to fill small gaps on walls roofs.

DO YOU KNOW?

EFFLORESCENCE

Certain hydrated crystalline salts when exposed to atmosphere lose their water of crystallization spontaneously and change into amorphous power.

The spontaneous loss of water of crystallization, wholly or partly, when crystals with water of crystallization are exposed to air is called efflorescence and the substance exhibiting efflorescence are called efflorescent substance.



For Example: Washing soda (Na_2CO_3. $10H_2O$), Glauber's salt (Na_2SO_4.10 H_2O), blue vitriol ($CuSO_4$. $5H_2$ O)

DELIGUESENCE

Certain crystalline substance when exposed to atmosphere absorb moisture and change into solution.

The absorption of moisture from air by crystals to from a solution is called deliquescence.

Sodium hydroxide, potassium hydroxide, calcium chloride etc. are deliquescent substance.

HYGROSCOPC SUBSTANCES

Certain substance absorb water from the atmosphere without undergoing change in physical state. Such substance are known as **hydroscopic substance.**

Anhydrous sodium carbonate, anhydrous copper sulphate, concentrated sulphuric acid are examples of hygroscopic substances.

SOLVED QUESTIONS

1. What are acids?

Ans. A substance is an acid if it dissolves in water to provide hydrogen ions.

2. What is a base? Give one example.

Ans. Base is a substance which give OH^- ions when dissolved in water. An example of base is NaOH.

3. Write the equations for dissociation of hydrochloric acid (HCl) in water.

Ans. $HCl + H_2 \rightarrow H_3O^+ + Cl^-$

Or it can also be written as

$HCl + H_2O \rightarrow H^+(aq) + Cl^-(aq)$

4. Which one of have higher concentration of H^+ ions?

1M HCl or 1M CH_2COOH

Ans. 1M HCl will have higher concentration of H^+ ions.

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

Or

Why should water be never added dropwise to concentrated sulphuric acid?

Ans. While diluting an acid, water should not be added to a concentrated acid because the heat generated may cause the mixture to splash out.

6. How is the concentration of H_3O^+ ions affected when a solution of an acid is dilute?
Ans. The concentration of H_2O^+ ions affected when a solution of an acid is dilute.

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

8. What effects does the concentration of H^+ (aq) has on the acidic nature of the solution?
Ans. A solution is more acidic if it has high concentration of H^+ (aq) ions.

9. Do basic solution also have H^+ (aq) ions? If yes, then why are these basic?
Ans. Basic solution also have H^+ (aq) ions. A solution of an acid or a base always contains both H^+ (aq) ions as well OH^- (aq) ions. It shows basic character if it has more OH^- (aq) ions and acidic character if it has more H^+ (aq) ions.

10. Choose strong acid and strong base from the following: CH_3COOH, NH_4OH, KOH, HCl
Ans. Strong acid is HCl and strong base is KOH.

11. What is meant by pH of a solution?
Ans. pH value of a solution tells about its acidic or basic nature. Values less than 7 represents an acidic solution and above 7 indicates a basic solution.

12. Which is more acidic – a solution with pH = 6.0 or a solution with pH = 2.0?
Ans. A solution with pH = 2.0 is more acidic.

13. Which is more basic, a solution with pH = 9.0 or a solution with pH =13.0?
Ans. A solution with pH = 13.0 is more basic.

14. What effect does an increase in concentration of H^+ (aq) in a solution have on the pH of solution?
Ans. pH of solution decreases when the concentration of H^+ increases.

15. How would you show that lemon and tomato contain acids?
Ans. Both, lemon juice and tomato juice blue litmus red. It shows that both of them contain acids.

16. What is the action of the solution of sodium carbonate towards litmus?
Ans. Solution of sodium carbonate will turn the colour of red litmus into blue indicating that it is alkaline in nature.

17. Dry ammonia gas has no action on litmus paper but a solution of ammonia in water turns red litmus paper blue. Is it so?
Ans. Ammonia in water forms ammonium hydroxide. These hydroxide ions turn red litmus blue.

18. What is the action on litmus of:
(a) Dry ammonium gas? (b) Solution of ammonium gas in water?
Ans. (a) Dry ammonia gas has on action on litmus
(b) Solution of ammonium gas in water turns red litmus blue.

19. Why should curd and sour substance not be kept in brass and copper vessels?
Ans. Curd and sour substance contain acids which react with brass and copper.

20. Why do HCl, HNO_3, etc. show acidic character in aqueous solutions while solution of compounds like. C_2H_5OH and glucose do not show acidic character.
Ans. A substance will show acidic character if it gives H^+ ions when dissolved in water. Among these substance HCl and HNO_3 provide H^+ ions whereas C_2H_5OH and glucose do not give H^+ ions so they do not show acidic character.

21. Why does an aqueous solution of acid conduct electricity?
Ans. Aqueous solution of an acid conducts electricity because it dissociates to provide ions.

22. Given two unlabelled bottles, one containing dilute acid and the other water. How would you decide to label them?
Ans. Acid and water can be identified by testing with litmus. Water will not change the colour of red blue litmus whereas acid will change blue litmus into red.

23. Why does distilled water not conduct electricity whereas rain water does?
Ans. The electric current is carried by ions in solution. Distilled water has no ions whereas rain water is slightly acidic and contains ions so rain water conducts electricity.

24. 10 mL of a solution of NaOH is found be completely neutralised by 8 mL of a give solution of HCl. If we take 20 mL of the same solution of NaOH, the amount of HCl solution (the same solution as before) required to neutralize it, will be:
Ans. 16 mL. since the quantity of NaHO solution is double, it will require the double quantity of HCl solutions also.

25. What happens when carbon dioxide gas is passed through sodium hydroxide solution?
Ans. When carbon dioxide gas is passed through sodium hydroxide solution, sodium carbonate is formed.
$2NaOH + CO_2 \longrightarrow Na_2CO_3 + H_2O$

26. Name the sodium compound which is used, for softening hard water.
Ans. The sodium compound used for softening hard water is sodium carbonate ($Na_2CO_3. 10H_2O$)

27. What is the chemical name and formula of baking soda?
Ans. Chemical name if baking soda is sodium hydrogen carbonate and its formula is $NaHCO_3$.

28. A compound 'X' is an important ingredient of an antacid. It is also used in fire extinguishers. Identify 'X'.

Ans. Compound 'X' is sodium hydrogen carbonate ($NaHCO_3$).

29. Fresh milk has a pH of 6. How do you think the pH will changes as it turns into curd? Explain your answer.

Or

Fresh milk has a pH of 6. when it changes into curd (yogurt) will its pH value increase or decrease? Why?

Ans. The pH will decrease from 6 because it changes more acidic when milk is converted into curd and more acidic solution has lower pH value.

30. What is the neutralization reaction? Give two examples.

Ans. When an acid reacts with a base to from salt and water, it is called neutralisation reaction. Two examples are (i) the reaction between hydrochloride acid and sodium hydroxide and (ii) the reaction between sodium carbonate and sulphuric acid.

$HCl + NaOH \rightarrow NaCl + H_2O$

$Na_2CO_3 + H_2SO_4 \rightarrow Na_2SO_4 + H_2O + CO_2$

31. What happens when crystals of washing soda are left open industry air? What is this change named as?

Name two industries based on use of washing soda.

Ans. When crystals of washing soda are left open in dry air, they lose nine molecules of water of crystallization and become white powder.

$Na_2CO_3 + 10\ H_2O \xrightarrow{air} Na_2CO_3.\ H_2O + 9\ H_2O$

Washing soda White powder

This change is called efflorescence.

Two industries bases on the use of washing soda are:

(i) manufacture of glass

(ii) paper and textile industries.

32. What will happens if the solution of sodium hydrogencarbonate is heated? Give the equation of the reaction involved. **Or**

(i) Name the products formed when sodium hydrogen carbonate is heated.

(ii) Write the chemical equation for the reaction involved in the above.

33. When the solution of sodium hydrogencarbonate is heated is heated, it decomposes to from sodium carbonate with the evolution of carbon dioxide gas.

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

34. How is Plaster of Paris chemically different from gypsum? How many they are interconnected? Write one use of Plaster or Paris.

Or

How is Plaster of Paris obtained? What reaction is involved in the setting of a paste of Plaster of Paris?

Or

State the chemical difference between Plaster of Paris and gypsum. Describe their either way inter conversions.

Ans. Plaster of Paris is chemically different from gypsum in terms of water of crystallization of water per mole of $CaSO_4$, ($CaSO_4.1/2H_2O$). It can also be written as if one mole of water of crystallization is present for two moles of $CaSO_4$, ($2CaSO_4.H_2O$). Gypsum on heating at 373 K gets converted into Plaster of Paris.

$$CaSO_4.2H_2O \xrightarrow[373\ K]{Heat} CaSO_4 + 1/2\ H_2O + 11/2\ H_2O$$

Gypsum Plaster of Paris

When Plaster of Paris is mixed with water, it gets converted into gypsum.

$$CaSO_4 + ½\ H_2O + 11/2\ H_2O \xrightarrow[373\ K]{Heat} CaSO_4.2H_2O$$

Plaster of Paris Gypsum

Plaster of Paris is used for making statues and for setting of fractured bones.

35. Name three compounds of calcium which are used in day-to-day life and write one important use of each of them.

Ans. The three compounds of calcium and their used are:

(i) Slaked lime [Calcium hydroxide, $Ca(OH)_2$] – used for the manufacture of bleaching power.

(ii) Bleaching powder [Calcium oxychloride, $CaOCl_2$] – used as bleaching agent in laundry.

(iii) Plaster pf Paris [Calcium sulphate hemihydrate, $CaSO_4.1/2H_2O$]- used to Plaster the fractured bones.

PREVIOUS YEAR'S BOARD QUESTIONS

36. A chemical compound having smell of chloride is used to remove yellowness of white clothes in laundries. Name the compound and write the chemical equation involved in its preparation.

[CBSE Delhi 2001 Supp.]

Ans. The compound is bleaching power ($CaOCl_2$). It remove yellowness from clothes due to its bleaching action. For details, consult text part.

37. Explain giving reasons:

(i) Tartaric acid is a compound of baking powder used in making cakes.**[CBSE Sample paper 2003]**

(ii) Gypsum, $CaSO_4.2H_2O$ is used in the manufacture of cement. **[CBSE Sample paper 2003]**

Ans. (i) Role of tartaric acid in baking powder (mixture of tartaric acid and sodium hydrogen carbonate) is to neutralize sodium carbonate formed upon heating sodium hydrogen carbonate.

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

Sod. Hydrogen carbonate Soda. Carbonate

(ii) The role of gypsum ($CaSO_4.2H_2O$) in the manufacture of cement is to slow down the process of setting of cement.

38. What happens when crystals of washing soda are exposed air?

[CB.S.E Delhi 2003: CB.S.E. All India 2005]

Ans. Washing soda undergoes efflorescence and as a result loses nine molecules of water to from white powder.

$Na_2CO_3.10H_2O \xrightarrow{(Air)} Na_2CO_3.H_2O + 9H_2O$

Washing soda (white crystals) — Washing powder (white powder)

39. How is chloride of lime chemically different from calcium chloride? Why does chloride of lime gradually lose its chlorine when kept exposed to air?

Ans. Chloride of lime is calcium oxy chloride [(Ca(OCl)Cl] also known as bleaching powder. Calcium chloride is CaCl2. Bleaching powder loses its chlorine on exposure to air because CO_2 present in air reacts with it to evolve chloride as follows:

$CaCl_2 + CO_2 \longrightarrow CaCO_3 + Cl_2$

Chloride of lime (Bleaching powder) (Air)

40. What is the chemical name of washing soda? Name three raw materials used in making washing soda by Solvay process. **[C.B.S.E. Delhi 2004]**

Ans. **Chemical name:** Sodium carbonate decahydrate ($Na_2CO_3.10\ H_2O$)
Raw materials: Brine, lime stone. Ammonia.

41. State the chemical property in each case on which the following used of baking soda are based
(i) as an antacid
(ii) as a constituent of baking powder.

Ans. (i) It is weakly alkaline in nature and neutralizes acid (HCl) formed in the stomach.

$NaHCO_3 + HCl \longrightarrow NaCl + H_2O + Co_2$

(ii) It evolves CO_2 in the form of bubbles when cake is made by baking. As a result, the cake becomes porous as well as fluffy.

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

42. How is Plaster of Paris obtained? What reactions are involved in the setting of Plaster of Paris?

[C.B.S.E. Delhi 2004]

Ans. For answer, consult text parts.

43. How is Plaster of Paris chemically different from gypsum? How may these be inter converted? Write one use of Plaster of Paris.

Ans. For details, consult text-part.

44. Name two industries based on the use of washing soda. **[C.B.S.E. All India 2004]**

Ans. The two industries are: glass industry and paper industry.

45. Write chemical name and formula of washing soda. What are the raw materials used for its manufacture by Solvay, process? What happens when, crystals of washing soda are exposed to air? **[C.B.S.E. Delhi 2005 Compt.]**

Ans. For answer, consult text part.

46. (a) Name the two chief chemicals used for making a soda acid fire extinguisher.
(b) How does the soda- acid fire extinguisher help to extinguish the fire? **[C.B.S.E. All India 2006]**

Ans. (a) The two chief chemical are: sodium hydrogen carbonate ($NaHCO_3$) and sulphuric acid (H_2SO_4)
(b) For the details of the operation, consult text part.

47. What is efflorescence? Give an example. **[C.B.S.E. Delhi 2006]**

Ans. For details, consult text part.

48. (a) An aqueous solution has a pH value of 7.0 Is this solution acidic, basic or neutral?
(b) If H^+ concentration of a solution is $1x10^{-2}$ mol L^{-1}, what will be its pH value?
(c) Which has a higher pH value: I-M HCl or l-M NaOH solution? **[C.B.S.E Delhi 2006]**

Ans. (a) The solution with pH value of 7.0 is neutral in nature
(b) Give: $[H^+] = 1 \times 10^{-2}$ mol $L^{-1} = 10+^{-2}$ M.

$$pH = \log\left[\frac{1}{H^+}\right] = -\log[H^+] = -\log[10^{-2}] = (-2)\log 10 = 2$$

(c) 1 M NaOH solution (basic) has higher pH value than 1 M HCl solution (acidic).

49. Out of calcium compounds calcium carbonate, quick lime and slaked lime, which one can used for removing moisture from ammonia gas and why? **[C.B.S.E. Foreign 2006]**

Ans. Quick lime (CaO) can be used to remove moisture from ammonia gas because of hygroscopic nature. Therefore, it can act as the best dehydrating agent for ammonia.

50. (a) Name the raw materials used in the manufacture of sodium carbonate by Solvay process.
(b) How is sodium hydrogen carbonate formed during Solvay process separated from a mixture of NH_4Cl and $NaHCO_3$?
(c) How is sodium carbonate obtained from sodium hydrogen carbonate? **[C.B.C.E All India 2006]**

Ans. (a) The raw materials used are: NaCl, lime stone or $CaCO_3$ and NH_3.
(b) Sodium hydrogen carbonate ($NaHCO_3$) is sparingly soluble or less soluble in water and gets separated as a precipitate while NH_4Cl remains in solution. The precipitate is removed by filtration.
(c) Sodium hydrogen carbonate is converted to sodium carbonate upon heating.

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

For further details, consult text part.

51. (a) What is the action of red litmus on (i) dry ammonia gas (ii) solution of ammonia gas in water
(b) State the observations you would make on adding ammonium hydroxide to aqueous solution of
(i) ferrous sulphate (ii) aluminium chloride. **[C.B.S.E All India 2006]**

Ans. (a) (i) Red litmus has no action on dry ammonia gas, because it does not release any hydroxyl ions $(OH)^-$

(ii) When passed through water, ammonia (NH_3) is converted to ammonium hydroxyl ions $(OH)^-$ to give hydroxyl ions (OH^-) and the solution is basic in nature. Red litmus acquires a blue colour.

(b) (i) A green precipitate of ferrous hydroxide will be formed by double decomposition reaction

$$FeSO_4(aq) + 2NH_4OH(aq) \longrightarrow Fe(OH)_2 + (NH_4)_2SO(aq)$$

(Green ppt.)

(ii) A white precipitate of aluminium hydroxide will be formed by double decomposition reaction.

$$AlCl_3(aq) + 3NH_4OH(aq) \longrightarrow Al(OH)_3 + 3NH_4Cl(aq)$$

(white ppt.)

52. How will you test for gas which is liberated when hydrochloric acid reacts with an active metal? **[C.B.S.E. All India 2008]**

Ans. Hydrogen gas is evolved when hydrochloric acid reacts with an active metal such as sodium, potassium, calcium or magnesium. In order to test the gas, bring either a burning a match stick or candle near the gas. The gas will immediately catch fire.

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

53. What is 'baking powder'? How does it make cake soft and spongy? **[C.B.S.E. All India 2008]**

Ans. For answer consult text part.

54. Name the gas evolved when dilute HCl reacts with sodium hydrogen carbonate. How is it recognized? **[C.B.S.E. All India 2008]**

Ans. The gas evolved is carbon dioxide (CO_2). When the gas is bubbled through lime water, it become milky.

55. What is meant by 'Water of Crystallisation'? How will you show blue copper sulphate crystals contaic water of crystallization? **[C.B.S.E. All India 2008]**

Ans. For answer consult text part

46. Arrange the following in increasing order of their pH values: NaOH solution, blood, lemon juice **[C.B.S.E. Foreign 2008]**

Ans. Increasing order of pH values is: lemon juice <blood < NaOH solution

47. Name the three products obtained on electrolysis of an aqueous solution of sodium chloride. Why is this called chlor-alkali process? **[C.B.S.E. Foreign 2008]**

Ans. For answer, consult Text part.

48. How does the pH change when the solution of base is diluted with water? **[C.B.S.E. Foreign 2008]**

Ans. Upon diluting a solution of base with water, the number of OH^- ions in solution per unit volume decrease
The basic strength of the base decreases and pH of solution decreases.

49. Write the chemical formulae of washing soda and baking soda. Which of these two is an ingredient of antacids? How does it provide relief in stomach ache? **[C.B.S.E. Foreign 2008]**

Ans. Chemical formula of:
Washing soda: $Na_2CO_3.10H_2$); Baking soda: $NaHCO_3$
Baking soda is an ingredient of baking powder. It neutralises hydrochloric acid released in the stomach and reduces acidity. Therefore, it acts as antacid.

$$NaHCO_3 + HCl \longrightarrow NaCl + CO_2 + H_2O$$

50. Two solution A and B have pH value of 5 and 8 respectively. Which solution will be basic in nature?
[C.B.S.E. Delhi 2008]

Ans. The solution B with pH value of 8 will be basic in nature.

51. A compound 'X' of sodium is commonly used in kitchen for making crispy pakoras. It is also used for curie acidity in the stomach. Identify 'X'. What is its chemical formula? State the reaction that takes place when is heated during cooking. **[C.B.S.E. Delhi 2008 Compt.]**

Ans. The compound "X' is a constituent of baking powder. It is called baking soda. Chemically, the compound is sodium hydrogen carbonate with formula $NaHCO_3$.
Upon heating, the compound 'X' will release carbon dioxide gas.

$$2NaHCO_3 \xrightarrow{\text{Heat}} Na_2CO_3(s) + H_2O(l) + CO_2(g)$$

52. (a) Why does an aqueous solution of an acid conduct electricity?
(b) How does the concentration of hydrogen ions $[H_3O]^+$ change when the solution of an acid is diluted with water?
(c) Which has a higher pH value; a concentrated or dilute solution of hydrochloric acid?
(d) What would you observe on adding dilute hydrochloric acid to
(i) sodium bicarbonate placed in a test tube?
(ii) zinc metal in a tube? **[C.B.S.E. All India 2008 Compt.]**

Ans. (a) An aqueous solution of an acid conducts electricity because in water, an acid (e.g. HCl) dissociates to give ions. Since the current is carried by the movement of ions, an aqueous solution of acid conducts electricity.

(b) Upon dilution, more of acid dissociates into ions. Therefore, concentration of $[H_3O]^+$ ions will Increase upon dilution.

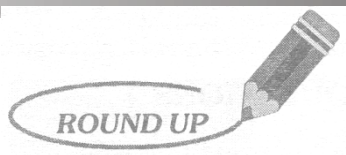
(c) Although more $[H_3O]^+$ ions are formed upon dilution, but the number Therefore, pH will increase Upon dilution.

(d) (i) Carbon dioxide gas will evolve accompanied by brisk effervescence.

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

(ii) Hydrogen gas will evolve accompanied by brisk effervescene.

$$Zn(s) + 2HCl(aq) \longrightarrow ZnCl_2(aq) + H_2(g)$$



- Acid-base indicators are organic dyes derived from plant materials which show the presence of acids and bases.
- Phenolphthalein and methyl orange are synthetic indicators which show the presence of acids and bases.
- Acidic nature of the substance is due to the formation of H^+(aq) ions in an aqueous solution.
- Basic nature of the substance is due to the formation of OH^-(aq) ions in an aqueous solution.
- Metal displace hydrogen from alkalis, forming a metal salt containing oxygen.
- A few metal displace hydrogen from alkalis, forming a metal salt containing oxygen.
- Acids react with metal oxides and metal hydroxides (bases) to from their respective salts and water as the only products.
- Acids react with metal carbonate to from their respective salts, water and carbon dioxide gas.
- Acidic and basic solution conduct electricity, because they produce H^+(aq) and OH(aq) ions respectively.
- In a neutralization reaction, the H^+(aq) ions of an acid react with OH^-(aq) ions of a base to from water.
- The strength of an alkali can be tested by using pH scale (0-14) which gives the concentration of H^+(aq) ions in a solution.
- A neutral solution has pH 7. Acidic substance have pH less than 7. The alkaline substance have pH more than 7.
- Living being carry out various metabolic activities within the pH range of 7 to 7.8.
- Mixing of concentrated acids and alkalis in water is a highly exothermic reaction.
- Salts of pH 7 are called normal salts. They are formed when a strong acid neutralises strong alkali.
- Salts of pH more than 7 are called basic salts. They are formed when a strong alkali reacts with weak base.
- Salts of various metal have various uses in industry and everyday life.
- Water of crystallisation is a fixed number of water molecules chemically attached to each formula unit of a salt in crystalline form.
- Crystalline salts containing water of crystallisation are called hydrated salts.

EXERCISE # 1 SCHOOL/ BOARD EXAMS.

(A) OBJECTIVE TYPE QUESTIONS:

1. A solution turns red litmus blue, its pH is likely to be-
(A) 1 (B) 4 (C) 5 (D) 10

2. A solution reacts with crushed egg-shells to give a gas that turns that lime-water milky. The solution contains-
(A) NaCl (B) HCl (C) LiCl (D) KCl

3. 10 mL of a solution of NaOH is found to be completely neutralized by 8mL of a given solution of HCl. If we take 20 mL of the same solution of NaOH, the amount HCl solution (the solution as before) required to neutralise be-
(A) 4 mL (B) 8 mL (C) 12 mL (D) 16 mL

4. Which one on of the following types of medicines is used for treatment indigestion-
(A) Antibiotic (B) Analgesic (C) Antacid (D) Antiseptic

5. According to Arrhenius acid gives –
(A) H^+ in water (B) OH^- in water (C) Both (A) & (B) (D) OH^- in acid medium

6. Milk of magnesia is an –
(A) Acid (B) Antacid (C) Alkali (D) Rock salt

7. Noble metals are dissolved in –
(A) Conc. HNO_3 (B) Conc. HCl (C) Conc. H_2SO_4 (D) Aqua-regia

8. Which of the following ia not a strong acid?
(A) H_2SO_4 (B) CH_3COOH (C) HNO_3 (D) HCl

9. Soda ash is –
(A) $Na_2CO_3H_2O$ B)Na_2CO_3 (C) NaOH (D)$NaHCO_2$

10. Which of the following is an basic salt?
(A) $SnCl_2$ (B) NaCl (C) NH_4Cl (D) CH_3COONa

11. Which of the following method is not used in preparing a base?

(A) Burning of metal in air (B) Adding water to a metal oxide.

(C) Reaction between an acid and base. (D) Heating metal carbonates.

12. Fats + NaOH $\longrightarrow$.....+ Glycerol. One of the product formed in this reaction is-

(A) Soap (B) Cloth (C) Paper Wood

13. Potash alum is a?

(A) Simple salt (B) Complex salt (C) Acid salt (D) Double salt

14. $NaHCO_3$ represent the formula of which one of the following?

(A) Sodium carbonate (B) Baking soda

(C) Sodium acetate (D) Washing soda

(B) FILL IN THE BLANKS:

1. An indicator changes its ……..with change of the nature of the solution.

2. The properties of……. are due to the hydrogen ions it produces in aqueous solution.

3. A water soluble base produces……..ions in solutions.

4. A farmer treats the soil of this with lime when the soil has……nature.

5. Electrolysis of an aqueous solution of ……produces hydrogen at cathode, chlorine at anode and sodium hydroxide in the solution.

6. Hydrated copper sulphate contains five molecules of …….of crystallization.

7. Phenolphthalein gives a…….colour when added to sodium hydroxide solution.

8. Blue litmus turns red when added to……..solution.

9. The pH of an acidic solution is ……than 7.

10. $NaCl + H_2SO_4 \xrightarrow{\Delta}$ …….. + HCl.

11. $2P + 5H_2SO_4(conc.) \xrightarrow{\Delta}$ …….. + $2H_2O + 5SO_2$.

12. $3Fe + 4H_2O \rightleftharpoons$……. + H_2

ANSWER KEY

- **Objective type questions**

1. D	**2.**B	**3.** D	**4.C**	**5.**B	**6.**B	**7.**D
8.B	**9.**B	**10.**D	**11.**B	**12.**A	**13.**D	**14.**B

- **Fill in the blacks**

1. Colour	**2.** an acid	**3.** Hydroxide(OH^-)	**4.** Acidic
5. Sodium chloride	**6.** Water	**7.** Pink	**8.** an acidic
9. Less	**10.** $NaHSO_4$	**11.** $2H_3PO_4$	**12.** Fe_3O_4

EXERCISE # 2

(A) VERY SHORT ANSWEER TYPE QUESTIONS:

1. Name the acid present in (i) vinegar (ii) lemon (iii) orange

2. Which is a stronger acid and why: HCl or CH_3COOH.

3. Which type of acid forms only the normal salt?

4. Name the gas which is librated at cathode during the electrolysis of mineral acid.

5. Write the main use of boric acid.

6. How alkalis differ from bases? Explain

7. What will happen to the concentration of $[H^+]$ ions in a solution if NaOH is added to water?

8. Why does copper not react with dill. H_2SO_4 or dil.HCl?

9. Name the metals which are soluble only in aqua regia.

10. When concentration acid is diluted, does the pH get higher or lower?

(B) MATCH THE FOLLOWING:

1.

	Column-A **Compound**		**Column-B** **Chemical name**
(i)	Bleaching powder	(a)	Sodium bicarbonate
(ii)	Baking soda	(b)	Sodium carbonate
(iii)	Washing soda	(c)	Calcium oxychloride
(iv)	Plaster of Paris	(d)	Calcium sulphate hemihydrate

(C) SHORT ANSWER TYPE QUESTIONS:

1. How is Plaster of Paris obtained? What reaction is involved in the setting of a paste of plaster of Paris?

2. What happens when crystals of washing soda are left open in dry air. What is this named as?

3. How can you prepare acid-base indicator at home?

4. Write down the molecular formula for: Sulphate acid, Nitric acid, Phosphoric acid, Carbonic acid.

5. Name the gas evolved when dilute sulphate acid acts as sodium carbonate. Write the chemical equation for the reaction involved.

6. What does pH stand for? What does a pH scale indicate.

7. Differentiate between:

(i) Strong acid and concentration acid

(ii) Weak base and dilute base

8. 'Sweet tooth' may to tooth decay. Explain why? What is the role of toothpaste in preventing cavities?

9. A blue salt become white on heating. With the help of a reaction explain the change in colour.

10. Why do we not categorise metal oxides as salts while we categorise sulphate as salts?

11. What happen when electric current is passed through brine? Give reaction.

12. Select the formula of acids, bases and salts from the following list:

NaCl, NaOH, H_3PO_4, Na_2CO_3, $Ca(OH)_2$, $CuSO_4$, $5H_2O$, H_2CO_3, HCl, $NaHCO_3$, Na_2HCO_3, Na_2CO_3 $10H_2O$, $Al(OH)_3$, KCl

(D) LONG ANSWER TYPE QUESTIONS:

1. Dry HCl gas does not affect a dry blue litmus paper, whereas it changes a moist blue litmus paper to red. Explain.

2. What is the pH scale? How can you know, if they give sample is acidic, basic or neutral from its pH value.

3. How can you classify salts on the basis of their solubility in water? Give examples.

4. What is plaster of Paris? How is it prepared? Give the chemical equation.

5. Comment on the statement: Are the crystals of salts really dry?

6. Discuss chlor-alkali process for manufacturing sodium hydroxide.

CIDS, BASES & SALTS **EXERCIES**

- **Very short answer type**

1. (i) Acetic acid (ii) Citric acid (iii) Citric acid **2.** HCl, because it ionises completely in dilute aqueous solution

3. Monobasic acids **4.** Hydrogen **5.** For eye washing and as an antiseptic

6. All alkalis are water soluble while all bases are not water soluble

7. $[OH^-]$ concentration will increase **8.** Copper not a active metal

9. Pt and Au **10.** Higher

- **Match the following**

(i) → (c), (ii) → (a), (iii) → (b), (iv) → (d)