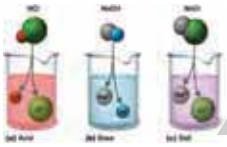


Chapter - 2

Acid, Bases And Salts

Properties of Acid
- Sour in taste
- Turn blue litmus red
- Give H+ ions in aqueous solution
- Aqueous soln conduct electricity

Properties of Bases
- Bitter in taste
- Turn red litmus blue
- Give OH^- ions in aqueous solution
- Does conduct electricity in aqueous soln

Physical Properties of Acids

Physical Properties of Bases

Acids, Bases and Salts

Chemical Properties of Acids

Chemical Properties of Bases

- Reacts with metals to liberate hydrogen.
- Reacts with metal carbonates/metal hydrogen carbonate to liberate CO2
- Reacts with certain metal oxides to form salt and water.

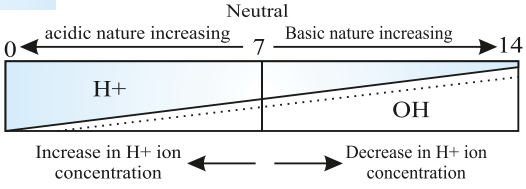
- Alkali reacts with metal to liberate H_2
- Bases reacts with acidic oxides to form water.

Classification of Acid, Bases and Salts on the basis of pH scale.

Salts : When acid and base are combined under the given condition. Salt is formed.

pH scale : H+ ion concentration of the solution.

Some Common Salts



Some Common Salts

- Common salt : NaCl
- Sodium hydroxide : $NaCl + 2H_2O \longrightarrow NaOH + Cl_2 + H_2$
- Bleaching Powder: $Ca(OH)_2 + Cl_2 \longrightarrow CaOCl_2 + H_2O$
- Baking Soda: $NaCl + H_2O + CO_2 + NH_3 \longrightarrow NH_4Cl + NaHCO_3$
- Wasing Soda: $Na_2CO_3 + 10.H_2O \longrightarrow Na_2CO_3.10H_2O$
- Plaster of Paris : $CaSO_4.2H_2O \xrightarrow[\text{heat}]{373\ k} CaSO_4.\frac{1}{2}H_2O + 1\frac{1}{2}H_2O$
- Gypsum : $CaSO_4.\frac{1}{2}H_2O + 1\frac{1}{2}H_2O \longrightarrow CaSO_4.2H_2O$

ACIDS :

- These are the substances which have sour taste.
- They turn blue litmus solution red.
- They give H^+ ions in aqueous solution.
- The term 'acid' has been derived from the Latin word, acidus, which means sour.

Strong Acids : HCl, H_2SO_4, HNO_3

Weak Acids : CH_3COOH, Oxalic acid, Lactic acid

Concentrated Acid : Having more amount of acid + less amount of water

Dilute Acid : Having more amount of water + less amount of acid

BASES :

- These are the substances which are bitter in taste and soapy in touch.
- They turn red litmus solution blue.
- They give OH^- ions in aqueous solution.

Strong Bases : NaOH, KOH, $Ca(OH)_2$

Weak Bases : NH_4OH

Alkalis : These are bases which are soluble in water [NaOH, KOH, $Ca(OH)_2$].

SALTS :

These are the compounds formed from reaction of acid and base.

Example :

NaCl, KCl.

INDICATORS :

These are the substances which change their colour/smell in different types of substances.

TYPES OF INDICATORS

Natural indicators

— Found in nature in plants.

— Litmus, red cabbage leaves extract, flowers of hydrangea plant, turmeric

Synthetic indicators

— These are chemical substances.

— Methyl orange, phenolphthalein

Olfactory indicators

— These substances have different odour in acid and bases.

— Vanilla, onion, clove

	S. No.	Indicator	Smell/Colour in acidic solution	Smell/Colour in basic solution
Natural Indicator	1.	Litmus	Red	Blue
	2.	Red cabbage leaf extract	Red	Green
	3.	Flower of hydrangea plant	Blue	Pink
	4.	Turmeric	No change	Red
Synthetic Indicator	1.	Phenolphthalein	Colourless	Pink
	2.	Methyl orange	Red	Yellow
Olfactory Indicator	1.	Onion	Characteristic smell	No smell
	2.	Vanilla essence	Retains smell	No smell
	3.	Clove oil	Retains smell	Loses smell

CHEMICAL PROPERTIES OF ACIDS AND BASES

Reaction of Metals with

Acids	Bases
Acid + Metal → Salt + Hydrogen gas	Base + Metal → Salt + Hydrogen gas
E.g., $2HCl + Zn \rightarrow ZnCl_2 + H_2\uparrow$	*E.g.,* $2NaOH + Zn \rightarrow Na_2ZnO_2 + H_2\uparrow$ (Sodium zincate)

* Hydrogen gas released can be tested by bringing burning candle near gas bubbles, it burns with pop sound.

Reaction of Metal Carbonates/Metal Hydrogen Carbonates with

Acids

Acid + Metal Carbonate/ Metal Hydrogen Carbonate → Salt + CO_2 + H_2O

E.g., $2HCl_{(aq)} + Na_2CO_{3(s)} \rightarrow 2NaCl_{(aq)} + CO_{2(g)} + H_2O_{(l)}$

$HCl_{(aq)} + NaHCO_{3(s)} \rightarrow NaCl_{(aq)} + CO_{2(g)} + H_2O_{(l)}$

Bases

Base + Metal Carbonate/ Metal Hydrogen Carbonate → No Reaction

* CO_2 can be tested by passing it through lime water.

$Ca(OH)_2 + CO_2 \rightarrow \underset{\text{insoluble}}{CaCO_3} + H_2O$ (Lime water turns milky.)

When excess *CO_2 is passed,

$CaCO_3 + CO_2 + H_2O \rightarrow \underset{\text{(Soluble)}}{Ca(HCO_3)_2}$ (Milkiness disappears.)

Reaction of Acids and Bases With Each Other

Acid + Base → Salt + H_2O

Neutralisation Reaction : Reaction of acid with base to give salt and water is called as **neutralisation** reaction.

E.g., $HCl + NaOH \rightarrow NaCl + H_2O$

IF :

Strong Acid + Weak Base → Acidic salt + H_2O [pH of the Solution is less than 7]

Weak Acid + Strong Base → Basic salt + H_2O [pH of the Solution is more than 7]

Strong Acid + Strong Base → Neutral salt + H_2O [pH of the Solution is = 7]

Weak Acid + Weak Base → Neutral salt + H_2O [pH of the Solution is = 7]

Reaction of Metallic Oxides with Acids

Metallic oxides + Acid ⟶ Salt + Water

Metallic oxides are basic in nature. because it reacts with acid and forms salt and water

E.g., CaO, MgO are basic oxides.

Metallic Oxide + Acid → Salt + H_2O

$CaO + 2HCl \rightarrow CaCl_2 + H_2O$

Reaction of Non-metalic Oxides with Bases

Non-metallic oxides are acidic in nature.

Non-mettalic Oxide+Base → Salt+H_2O

$CO_2 + Ca(OH)_2 \rightarrow CaCO_3 + H_2O$

Reaction of Acid

- + Metal Carbonate → Salt + CO_2+Water
- + Metal → Salt+H_2
- + Metal Hydrogen Carbonate → Salt+CO_2+H_2O
- + Metal oxide → Salt + H_2O
- + Base → Salt + H_2O

Reaction of Base

- + Metal → Salt+H_2
- + Metal Carbonate → No Reaction
- + Metal Hydrogen Carbonate → No Reaction
- + Acid → Salt + H_2O
- + Non Metallic oxide → Salt + H_2O

What do all Acids and Bases have in common

- All acids have H^+ ions in common.
- Acids produce H^+ ions in solution which are responsible for their acidic properties.
- All bases have OH^- (hydroxyl ions) in common.

All → Acids → H^+ ions

All → Bases → OH^- ions

Acid or Base in Water Solution

- Acids produce H^+ ions in presence of water.
- H^+ ions cannot exist alone, they exist as H_3O^+ (hydronium ions).

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

$$HCl + H_2O \rightarrow H_3O^+ + Cl^-$$

Bases when dissolved in water gives OH^- ions.

$$NaOH \xrightarrow{H_2O} Na^+ + OH^-$$

$$Mg(OH)_2 \xrightarrow{H_2O} Mg^{2+} + 2OH^-$$

- Bases soluble in water are called alkali.
- While diluting acids, it is recommended that the acid should be added to water and not water to acid because the process of dissolving an acid or a base in water is highly exothermic.

If water is added to acid, the heat generated may cause the mixture to splash out and cause burns and the glass container may also break due to excessive local heating.

Adding water to acid may

Cause mixture to splash out

Break the glass container

Mixing an acid or a base with H_2O results in decrease of concentration of ions (H_3O^+/OH^-) per unit volume. Such a process is called as dilution.

Strength of Acid and Base

Strength of acid or base can be estimated using universal indicator.

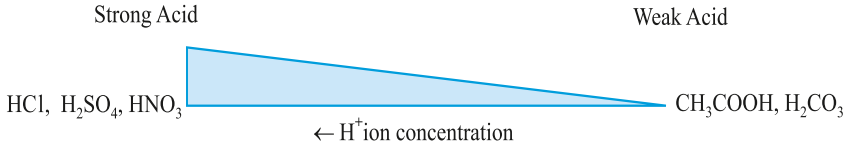
Universal indicator : is a mixture of several indicators. It shows different colours at different concentrations of H^+ ions in the solution.

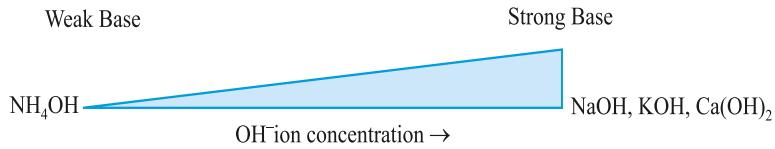
pH Scale : A scale for measuring H^+ ion concentration in a solution . p in pH stands for 'potenz' a German word which means power.

pH = 7 → neutral solution

pH less than 7 → acidic solution

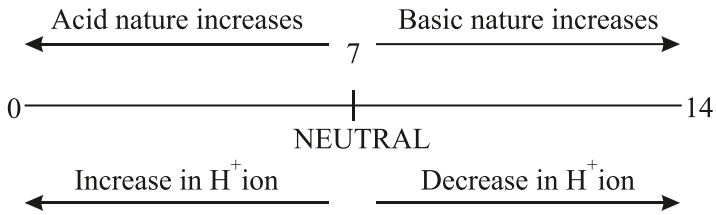
pH more than 7 → basic solution





On diluting an acid : pH increases ↑

On diluting a base : pH decreases ↓



Importance of pH in everyday life

1. Plants and animals are pH sensitive	• Our body works within the pH range of 7-7.8. • When pH of rain water is less than 5.6, it is called acid rain.
2. pH of the soil	• Plants require a specific pH range for their healthy growth. If the pH of soil of any place is less or more, then farmers have to mix some acidic or basic substances as required.

3. pH in our digestive system	• Our stomach produces HCl acid which helps in digestion. • During indigestion, stomach produces more acid and cause pain and irritation. • To get rid of this pain, people uses antacid (mild base) like milk of magnesia [$Mg(OH)_2$] to neutralize excess acid.
4. pH change as cause of tooth decay	• Tooth decay starts when pH of mouth is lower than 5.5. • Tooth enamel made up of calcium phosphate (hardest substance in body) does not dissolve in water but corrodes when pH is lower than 5.5 due to acids produced by degradation of food particles by bacteria. • Using toothpaste (generally basic) tooth decay can be prevented.
5. Self defence by animals and plants through chemical warfare	(a) Bee sting leaves an acid which cause pain and irritation. Use of a mild base like baking soda on stung area gives relief. (b) Stinging hair of nettle leaves inject methanoic acid causing burning sensation or pain. Rubbing with leaf of dock plant give relief.

pH of Salts :

(i) Strong Acid + Strong Base $\rightarrow$ Neutral Salt : pH = 7 eg. NaCl

(ii) Salt of strong acid + Weak base $\rightarrow$ Acidic salt : pH < 7 eg. NH_4Cl

(iii) Salt of strong base + Weak acid $\rightarrow$ Basic salt : pH > 7 eg. CH_3COONa

Chemicals from Common Salt (NaCl)

1.	2.	3.	4.	5.
Sodium Hydroxide (NaOH)	Bleaching Powder ($CaOCl_2$)	Baking Soda ($NaHCO_3$)	Washing Soda ($Na_2CO_3.10H_2O$)	Plaster of Paris ($CaSO_4.½H_2O$)

1. Sodium Hydroxide (NaOH) : When electricity is passed through an aqueous solution of NaCl (brine), it decomposes to form NaOH. (Chlor-alkali process)

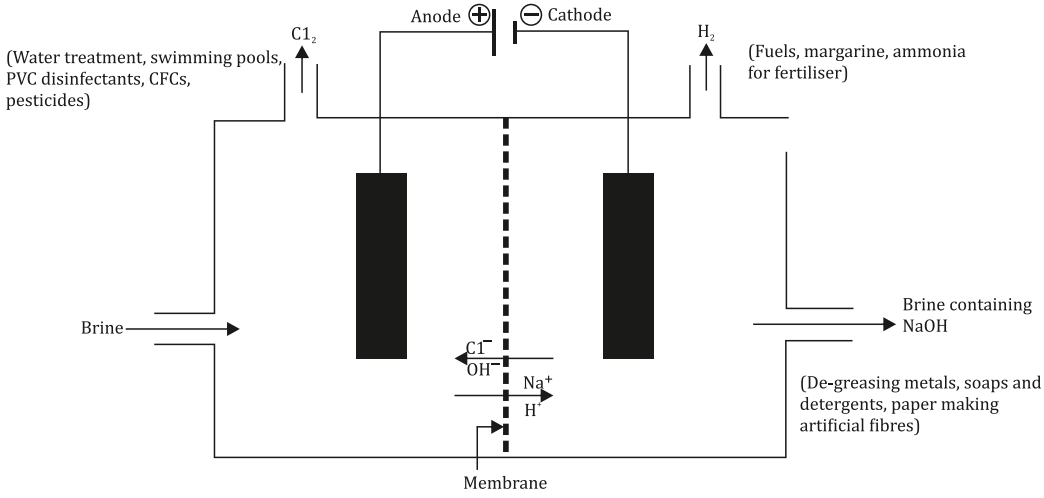


Figure 2.8 Important products from the chlor-alkali process

$$2NaCl + 2H_2O \rightarrow 2NaOH + Cl_2 + H_2$$

At anode : Cl_2 gas

At cathode : H_2 gas

Near cathode : NaOH solution is formed.

Uses :

H_2 : Fuels, margarine

Cl_2 : Water treatment, PVC, CFC's

HCl : Cleaning steels, medicines

NaOH : Degreasing metals, soaps and paper making

Cl_2 + NaOH $\rightarrow$ Bleach : Household bleaches, bleaching fabrics

2. Bleaching Powder ($CaOCl_2$): It is produced by the action of chlorine on dry slaked lime.

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

Uses :

(a) Bleaching cotton and linen in textile industry.

(b) Bleaching wood pulp in paper factories.

(c) Oxidizing agent in chemical industries.

(d) Disinfecting drinking water.

3. Baking Soda (Sodium Hydrogen Carbonate) ($NaHCO_3$) :

$$NaCl + H_2O + CO_2 + NH_3 \rightarrow NH_4Cl + \underset{\text{Baking soda}}{NaHCO_3}$$

- It is mild non-corrosive base.
- When it is heated during cooking :

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

Uses :

(a) For making baking powder (mixture of baking soda and tartaric acid). When baking powder is heated or mixed with water, CO_2 is produced which causes bread and cake to rise making them soft and spongy.

(b) An ingredient in antacid.

(c) Used in soda-acids, fire extinguishers.

4. Washing Soda ($Na_2CO_3.10H_2O$) : Recrystallization of sodium carbonate gives washing soda. It is a basic salt.

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

Uses :

(a) In glass, soap and paper industry.

(b) Manufacture of borax.

(c) Cleaning agent for domestic purposes.

(d) For removing permanent hardness of water.

5. Plaster of Paris (Calcium sulphate hemihydrates) ($CaSO_4.½H_2O$) :

On heating gypsum ($CaSO_4.2H_2O$) at 373K, it loses water molecules and becomes Plaster of Paris (POP).

It is a white powder and on mixing with water it changes to gypsum.

$$CaSO_4.½H_2O + 1½H_2O \rightarrow CaSO_4.2H_2O$$

Uses :

(a) Doctors use POP for supporting fractured bones.

(b) For making toys, material for decoration.

(c) For making surfaces smooth.

Water of Crystallization : It is a fixed number of water molecules present in one formula unit of a salt.

E.g., $CuSO_4.5H_2O$ has 5 water molecules.

$Na_2CO_3.10H_2O$ has 10 water molecules.

$CaSO_4.2H_2O$ has 2 water molecules.

VERY SHORT ANSWER TYPE OF QUESTION (1 MARK)

Q. 1 To protect tooth decay we are advised to brush our teeth regularly. The nature of tooth paste used is-

a) acidic b) neutral c) basic d) corrosive

Q. 2 A compound x in aqueous solution turns red litmus solution into blue Identify 'x'

a) Hydrochloric acid b) Ammonium hydroxide solution.

c) Sodium chloride solution d) Vinegar

Q. 3 Which one is stronger acid, with pH=5 or with pH=2 ?

Q. 4 What happens when chlorine is passed over dry slaked lime.

(CBSE-2010, 2011)

Q. 5 Dry HCl gas does not change the colour of dry blue litmus paper. Why?

Q. 6 Fill in the blanks-

a) The chemical formula of plaster of paris is _____.

b) Neutral substances have a pH=_____.

c) Gold can be dissolved in_____.

d) Commonoly used antacid is _____.