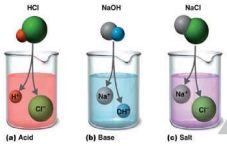


Chapter - 2

Acid, Bases And Salts

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	Synthetic indicators	Olfactory indicators
— Found in nature in plants.	— These are chemical substances.	— These substances have different odour in acid and bases.
— Litmus, red cabbage leaves extract, flowers of hydrangea plant, turmeric	— Methyl orange, phenolphthalein	

	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 $\rightarrow$ Salt + Hydrogen gas	Base + Metal $\rightarrow$ Salt + Hydrogen gas
E.g., $2HCl + Zn \rightarrow ZnCl_2 + H_2$	*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 burst with pop sound.

Reaction of Metal Carbonates/Metal Hydrogen Carbonates with

Acids	Bases
Acid + Metal Carbonate/ Metal Hydrogen Carbonate $\rightarrow$ Salt + $CO_2 + H_2O$	Base + Metal Carbonate/ Metal Hydrogen Carbonate
E.g., $2HCl + Na_2CO_3 \rightarrow 2NaCl + CO_2 + H_2O$	$\rightarrow$ No Reaction
$HCl + NaHCO_3 \rightarrow NaCl + CO_2 + H_2O$	

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

$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$ (Lime water turns milky.)

* When excess CO_2 is passed,

$CaCO_3 + CO_2 + H_2O \rightarrow Ca(HCO)_3$ (Milkiness disappears.)

Reaction of Acids and Bases With Each Other

Acid + Base $\rightarrow$ Salt + H_2O

Neutralisation Reaction : Reaction of acid with base is called as neutralization reaction.

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

IF :

Strong Acid + Weak Base $\rightarrow$ Acidic salt + H_2O

Weak Acid + Strong Base $\rightarrow$ Basic salt + H_2O

Strong Acid + Strong Base $\rightarrow$ Neutral salt + H_2O

Weak Acid + Weak Base $\rightarrow$ Neutral salt + H_2O

Reaction of Metallic Oxides with Acids

Metallic oxides are basic in nature.

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

Metallic Oxide + Acid $\rightarrow$ Salt + H_2O

$CaO + 2HCl \rightarrow CaCl_2 + H_2O$

Reaction of Non-metallic Oxides with Bases

Non-metallic oxides are acidic in nature.

Non-metallic Oxide + Base $\rightarrow$ Salt + H_2O

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

Reaction Of Acid

- + Metal Carbonate $\rightarrow$ Salt + CO_2 + Water
- + Metal $\rightarrow$ Salt + H_2
- + Metal Hydrogen Carbonate $\rightarrow$ Salt + CO_2 + H_2O
- + Metallic oxide $\rightarrow$ Salt + H_2O
- + Base $\rightarrow$ Salt + H_2O

Reaction Of Base

- + Metal $\rightarrow$ Salt + H_2
- + Metal Carbonate $\rightarrow$ No Reaction
- + Metal Hydrogen Carbonate $\rightarrow$ No Reaction
- + Acid $\rightarrow$ Salt + H_2O
- + Non Metallic oxide $\rightarrow$ 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 $\rightarrow$ H^+ ions
- Bases $\rightarrow$ 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).

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

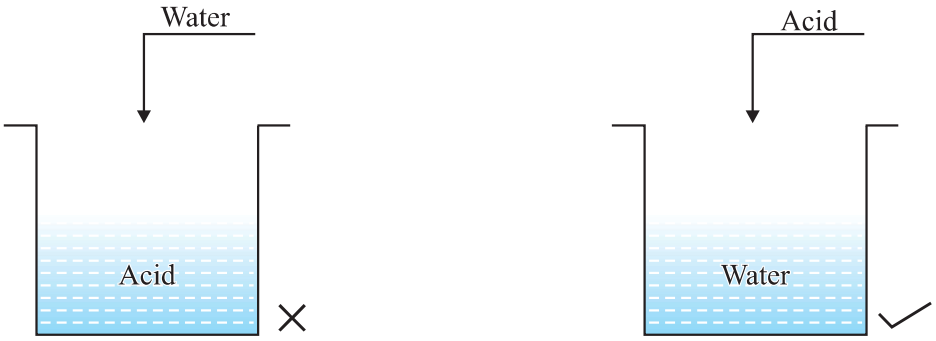
$$HCl + H_2O \rightarrow H_3O^+ + Cl^-$$

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.

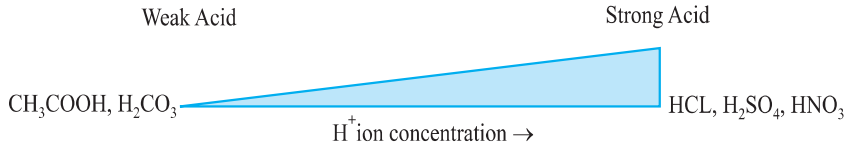
Universal indicator : is a mixture of several indicators. It shows different colours at different concentrations of H^+ ions in the solution.

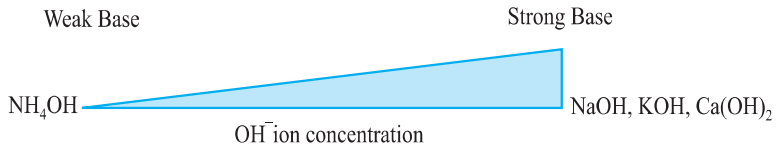
pH Scale : A scale for measuring H^+ ion concentration in a solution . p in pH stands for 'potenz' a German word which means power.

pH = 7 → neutral solution

pH less than 7 → acidic solution

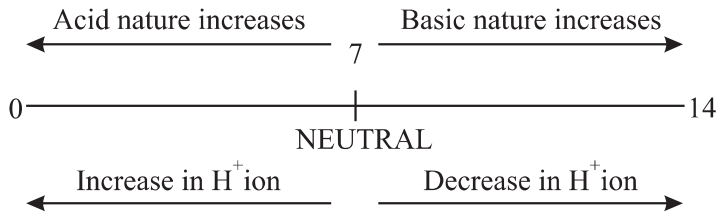
pH more than 7 → basic solution





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.

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.

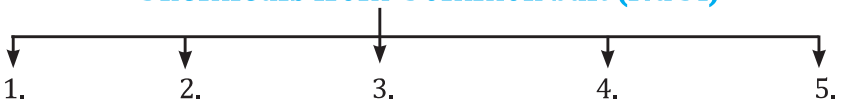
pH of Salts :

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

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

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

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 decompose to form NaOH. (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 → 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) ($NaHCO_3$) :**

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

Baking soda

- 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.

QUESTIONS

VERY SHORT QUESTIONS (1 Mark)

1. Name the acid present in ant sting.
2. What happens when egg shell is added to nitric acid ?
3. Name a salt which does not contain water of crystallization.
4. Name two constituents of baking powder.
5. What is the pH of gastric juices released during digestion ?
6. Which solution is used to dissolve gold ?
7. How will you test a gas which is liberated when HCl acid reacts with an active metal ?
8. Why does flow of acid rain water into a river make the survival of aquatic life in the river difficult ?
9. When conc. acid is added to water, whether the process is exothermic or endothermic ?
10. Which by-product of chlor-alkali process is used for manufacturing bleaching powder ?

SHORT TYPE QUESTIONS (2 Marks)

1. Why does bleaching powder smell strongly of chlorine and does not dissolve completely in water ?

2. Hold one moist and one dry strip of blue litmus paper over dry HCl acid gas. Which strip will turn red and why ?

3. What is Plaster of Paris ? How is it obtained from gypsum ?

4. What is the role of toothpastes in preventing cavities ?

5. Explain why sour substances are effective in cleaning copper vessels ?

6. A white powder is added while baking breads and cakes to make them soft and fluffy. What is the name of the powder ? What are its main ingredients ?

7. How washing soda is prepared from baking soda ?

8. Though the compounds such as glucose and alcohol have hydrogen atoms in their molecule, yet they are not categorized as acids. Why ?

9. What is the reaction called when an acid reacts with base to produce salt and water ? Give example also.

10. Why pickles and curd are not stored in copper and brass utensils ?

SHORT TYPE QUESTIONS (3 Marks)

1. On passing excess CO_2 through lime water, it first turns milky and then becomes colourless. Explain why ? Write chemical equations.

2. How are bases different from alkalis ? Are all bases alkalis ?

3. While constructing a house, a builder selects marble flooring and marble top for kitchen where vinegar and juices of lemon, tamarind etc. are more often used for cooking. Will you agree to this selection and why ?

4. Indicate with the help of a diagram the variation of pH with change in concentration of H^+ (aq) and OH^- (aq) ions.

5. Write the name and formulae of three hydrated salts.

6. What happens when calcium carbonate is made to react with hydrochloric acid ? Give the equation of reaction.

7. Why metallic oxides are called basic oxides and non-metallic oxides are called acidic oxides ?

8. What is pH scale ? What is pH value of salt formed by a

   (a) weak acid and strong base ?

   (b) strong acid and strong base ?

LONG ANSWER TYPE QUESTIONS (5 Marks)

1. What is water of crystallization ? Write the common name and chemical formula of a commercially important compound which has ten water molecules. How is this compound obtained ? Write chemical equations also. List any two uses of this compound.

2. Identify the compound X on the basis of the reactions given below. Also, write the name and chemical formulae ofA, B and C.

$$X + Zn \longrightarrow A + H_2 (g)$$

$$X + HCl \longrightarrow B + H_2O$$

$$X + CH_3COOH \longrightarrow C + H_2O$$

3. An element P does not react with dil. H_2SO_4. If forms an oxide PO which turns red litmus into blue. Will you call P as a metal or a non-metal ? Give reason.

Hints to Long Answer Type Questions

1. Washing soda ($Na_2CO_3.10H_2O$)

   Na_2CO_3 (s) + $10H_2O$ (*l*) $\rightarrow$ $Na_2CO_3.10H_2O$ (s)

2. $2NaOH + Zn \rightarrow Na_2ZnO_2 + H_2$

(X) (A)

$NaOH + HCl \rightarrow NaCl + H_2O$

(B)

$NaOH + CH_3COOH \rightarrow CH_3COONa + H_2O$

(C)

3. 'P' is a metal.