mImd. → 2, 3 Q. ⇒ Acid, Base & Salt

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Introduction to Acids, Bases and Salts

Classification of matter

- On the basis of

a) composition – elements, compounds and mixtures

b) state – solids, liquids and gases

c) solubility – suspensions, colloids and solutions

- Types of mixtures – homogeneous and heterogeneous

- Types of compounds – covalent and ionic

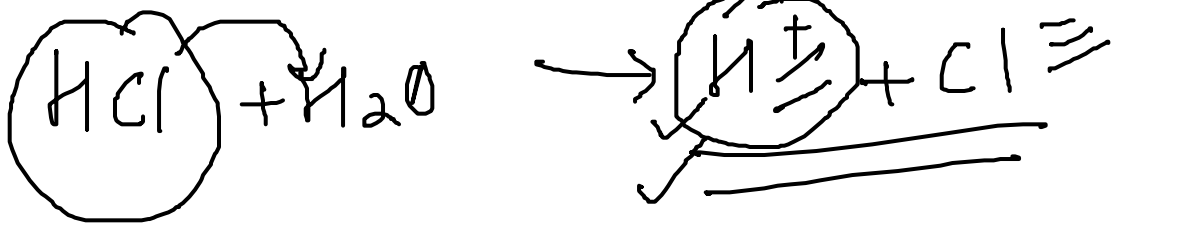
अम्ल ACIDS

⇒ Taste ⇒ Sour (खट्टे) ✓

⇒ Litmus Paper ⇒ Blue → Red ✓

⇒ Aq. Solution ⇒ electricity conduct. ✓

⇒ $[H^+]$ ⇒ Hydrogen ion.



. Properties of Acids:

– Produce hydrogen ions [H+] in H2O.

– Sour taste.

– Turn blue litmus red.

– Act as electrolytes in Solution.

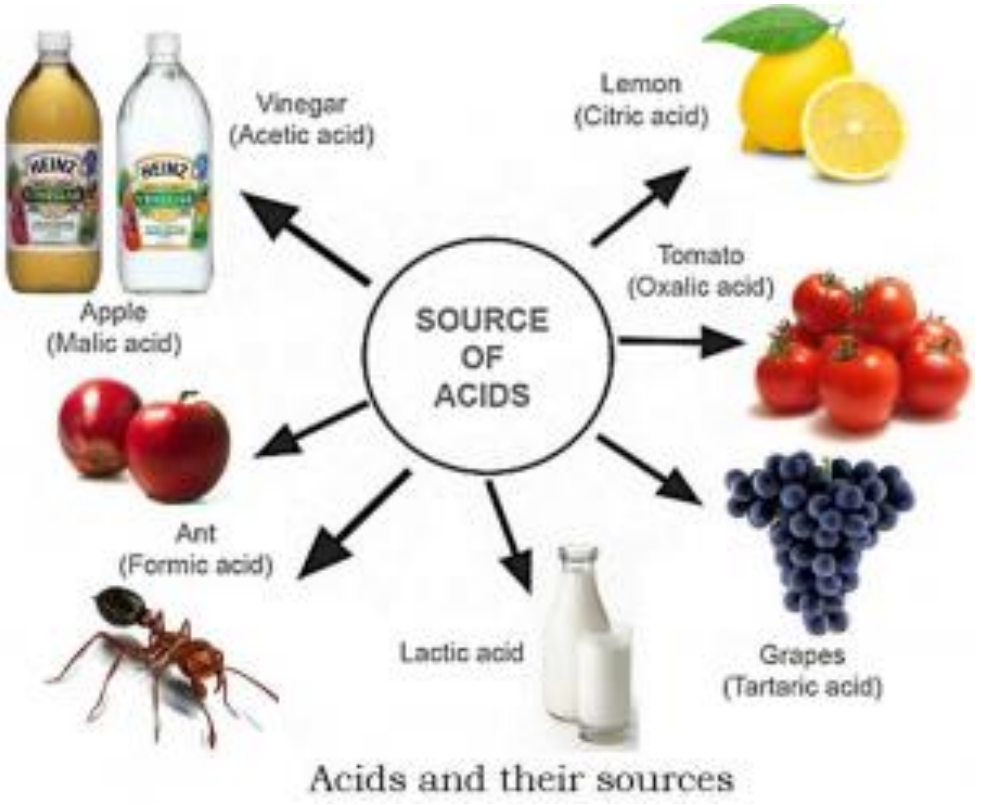
– Neutralize solutions carrying hydroxide ions.

– React with several metals releasing Hydrogen gas.

– React with carbonates releasing CO_2 (g)

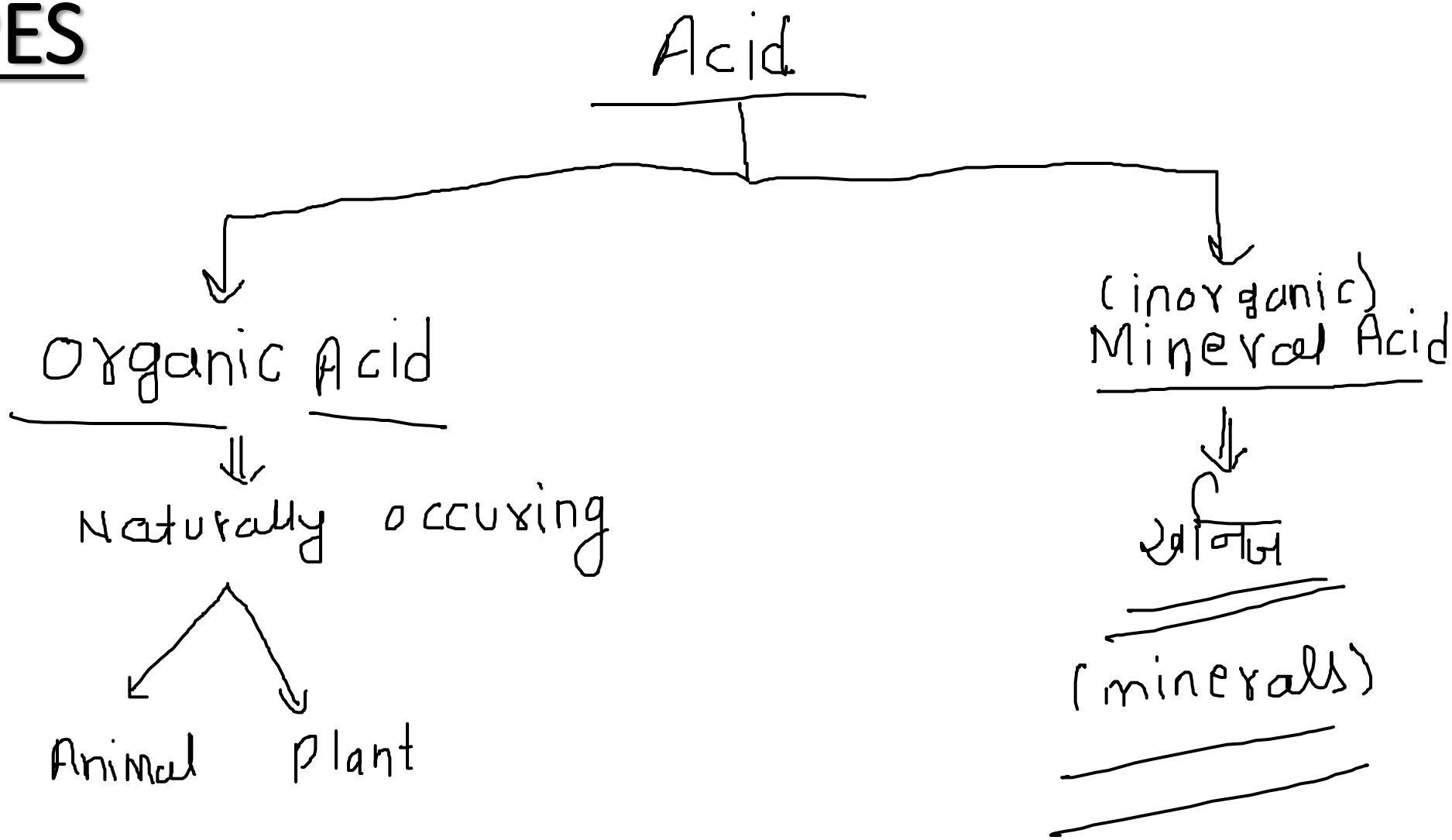
– Destroy body tissues.

– corrode metal surface quickly.



Acids and their sources

TYPES


Acid
Organic Acid
Naturally occuring
Animal
plant
(inorganic)
Mineral Acid
खनिज
(minerals)

- **On the basis of origin, acids are classified as :**

a. Organic acids: Acids derived from living organisms like plants and animals . For example: citric acid is present in fruits, acetic acid present in vinegar, oxalic acid present in tomato, tartaric acid present in tamarind, lactic acid present in sour milk and curd.

b. Mineral acids: They are also called inorganic acids. They are dangerous Example sulphuric acid(H_2SO_4), hydrochloric acid (HCl) etc.

ORGANIC ACIDS (Imp)

1. Formic Acid ⇒ Ant Sting, Bee Sting, Scorpian Sting, (Methanoic Acid)
2. Acitic Acid ⇒ Vinegar ← (Ethanoic Acid)
3. Citric Acid ⇒ Lemon / orange
4. Ascorbic Acid ⇒ citrus Fruits (खट्टे फल) ↓ (Amla)

5. Sulphonic Acid ⇒ Onion ⇒ Tear

6. Lactic Acid ⇒ curd

7. Malic Acid ⇒ Apple

8. oxalic Acid ⇒ Spinach + Tomato

9. Tartaxic Acid ⇒ Grapes + Tamarind

10 Siolic Acid → Tear

11 Glutomic Acid → Wheat

12 Nucleic Acid ⇒ DNA | RNA

13 Amino Acid ⇒ Protein

MINERAL ACIDS

✓ ✓ ⇒ 1st mineral Acid

① H_2SO_4 ⇒ Sulphuric Acid

⇓

oil of vitroil

⇓

King of Acid

② HCl ⇒ Hydrochloric Acid

③ HNO_3 ⇒ Nitric Acid

* Aqua Regia ⇒ (अम्लराज)

[HCl + HNO_3] conc.

3 : 1

⇒ Dissolve metals:-

[Au, Pt] ⇒ Inert metal

⇒ Goldsmith (सुनार)

➢ On the basis of their strength, acids are classified as :

a. Strong acids: Completely dissociate into its ions in aqueous solutions. Example: Nitric acid (HNO_3), sulphuric acid (H_2SO_4), hydrochloric acid (HCl).

b. Weak acids: Weak acids are those acids which do not completely dissociate into its ions in aqueous solutions. For example: carbonic acid (H_2CO), acetic acid (CH_3COOH).

➢ On the basis of their concentration, acids are classified as :

a. Dilute acids: Have a low concentration of acids in aqueous solutions.

b. Concentrated acids: Have a high concentration of acids in aqueous solutions.

➢ On the basis of number of hydrogen ion, acids can be classified as :

- **Monoprotic acid –** Such type of acid produces one mole of H+ ions per mole of acid, e.g., HCl ,HNO_3

- **Diprotic acid –** They can produce two moles of H+ ions per mole of acid, e.g., H_2SO_4.

- **Triprotic acid –** They produce three moles of H+ ions per mole of acid, e.g., H_3PO_4.

- **Polyprotic –** They can produce more than three H+ ions per mole of acid.

ACID RAIN (अम्ल वर्षा)

⇒ cause :- [Factory exhaust]

⇒ Gases :- [SO_2 , NO_2]

⇒ $SO_2 + H_2O \Rightarrow H_2SO_4$

$NO_2 + H_2O \Rightarrow HNO_3$

Acid ⇒ H_2SO_4 , HNO_3

BASE (भारम , क्षार) ⇒

- Taste ⇒ Bitter (कड़वे)
- Litmus Test ⇒ Red → Blue
- Aq. Solution ⇒ electricity conduction
- $[OH^-]$ ⇒ $NaOH + H_2O \longrightarrow Na^+ + OH^-$

Hydroxide ion

➢ Properties of Base:

– Produce hydroxide ions [OH –] in H2O.

– Water soluble bases are called alkalies.

– Bitter Taste

– Turn Red Litmus blue.

– Act as electrolytes in Solution.

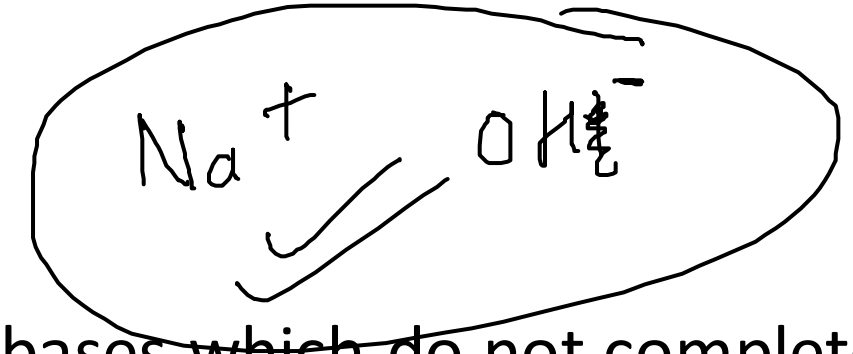
– Neutralize solutions containing H+ ions.

– Have a slippery, ‘soapy’ feel.

– Dissolve fatty material.

➢ On the basis of their strength, bases are classified as:

a. Strong bases: Strong bases are those bases which completely dissociate into its ions in aqueous solutions. Example: sodium hydroxide (NaOH), potassium hydroxide (KOH).



b. Weak bases: Weak bases are those bases which do not completely dissociate into its ions in aqueous solutions. For example: ammonium hydroxide (NH4OH).

➢ On the basis of their concentration, bases are classified as:

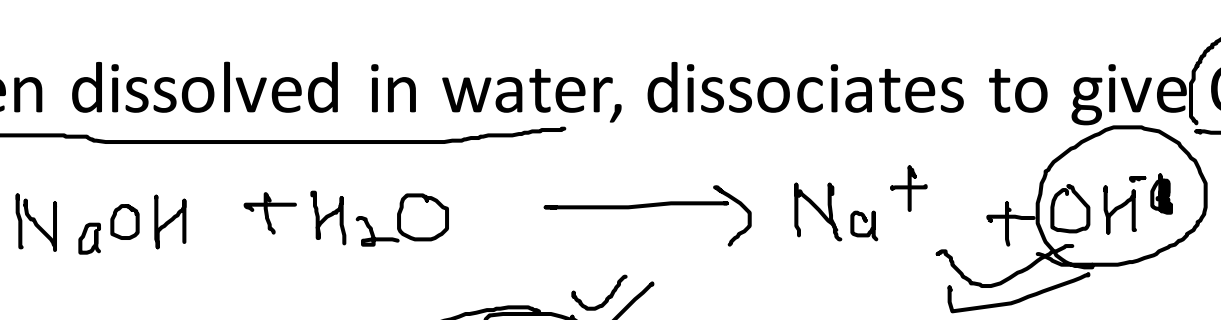
a. Dilute bases: Have a low concentration of alkali in aqueous solutions.

b. Concentrated bases: Have a high concentration of alkali in aqueous solutions.

Arrhenius theory of acids and bases

- Arrhenius acid – when dissolved in water, dissociates to give H^+ (aq) or H_3O^+ ion.

- Arrhenius base – when dissolved in water, dissociates to give OH^- ion.



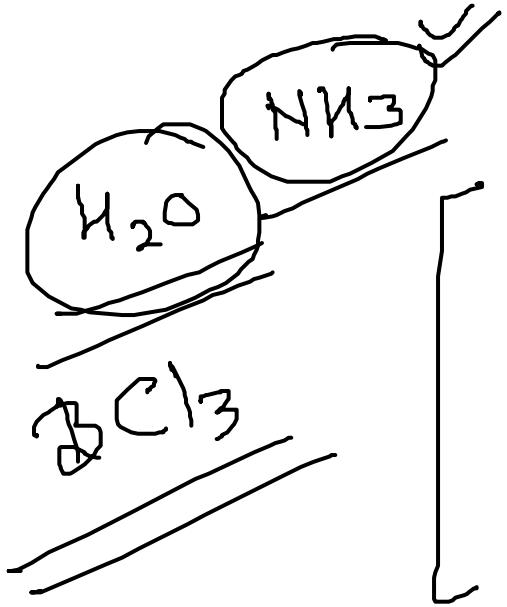
- Examples

- **Acids**

Hydrochloric acid (HCl)

Sulphuric acid (H_2SO_4)

Nitric acid (HNO_3)



- **Bases**

Sodium hydroxide (NaOH)

Potassium hydroxide (KOH)

Calcium hydroxide ($Ca(OH)_2$)

- **Bronsted Lowry theory**

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

Acid — Acid — [Conj Acid] — [Conjugate Base]

A Bronsted acid is an H^+ (aq) ion donor.

⇒ Donate ⇒ [H⁺]

A Bronsted base is an H^+ (aq) ion acceptor.

- **Example**

$HCl + NH_3 \rightarrow NH_4 + Cl^-$

Acid — Base

[Base ⇒ [H⁺] ⇒ Acceptor]

- In the reaction: $HCl\ (aq) + NH_3\ (aq) \rightarrow NH^+_4(aq) + Cl^-\ (aq)$
- HCl – Bronsted acid and Cl^- : its conjugate acid
- NH_3 – Bronsted base and NH^+_4 : its conjugate acid

Base ⇒ Accept proton

Acid ⇒ Donate

LEWIS CONCEPT

$[HCl + H_2O \longrightarrow H^+ + Cl^-]$

Acid ⇒ Accept electrons

Base ⇒ Donate electrons

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

H_3O^+ : Base

Cl^- : Acid

$NH_3 + H^+Cl$

NH_3 : Base

H^+Cl : Acid

Negative

CH_3NH_2

NH_3

(3) CH_3, CH_3, NH — Base

- **Physical test**

Given are two possible physical tests to identify an acid or a base.

→ weak Acid

a. Taste: An acid tastes sour whereas a base tastes bitter. The method of taste is not advised as an acid or a base could be contaminated or corrosive.

b. Effect on indicators by acids and bases

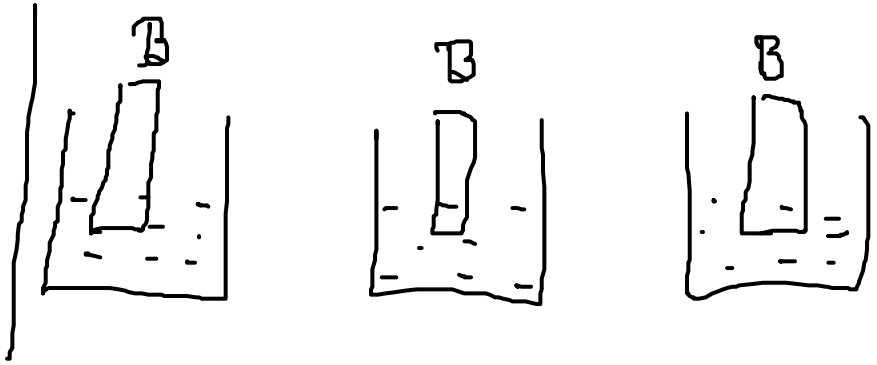
- An indicator is a chemical substance which shows a change in its physical properties, mainly color or odor when brought in contact with an acid or a base.

a) Litmus (Natural ⇒ Lichen → Plant)

In a neutral solution – purple

In acidic solution – red

In basic solution – blue



- Litmus is also available as strips of paper in two variants – red litmus and blue litmus.
- An acid turns a moist blue litmus paper to red.
- A base turns a moist red litmus paper to blue.

- **b) Methyl orange** (Art.)

In a neutral solution – orange

In acidic solution – red

In basic solution – yellow

- **c) Phenolphthalein**

(man made)

In a neutral solution – colorless → [H_2O]

In acidic solution – remains colorless → [HCl]

In basic solution – pink [NaOH]

TURMERIC

Turmeric (हल्दी)

⇒ Neutral ⇒ Color ⇒ [Yellow]

⇒ Acid ⇒ Yellow

⇒ Base ⇒ Red [Reddish Brown]

Reactions of acids and bases

a) Reaction of acids and bases with metals

Acid + active metal → salt + hydrogen + heat

$2HCl + Mg \rightarrow MgCl_2 + H_2 (\uparrow)$

Base + metal → salt + hydrogen + heat

$2NaOH + Zn \rightarrow Na_2ZnO_2 + H_2 (\uparrow)$

A more reactive metal displaces the less reactive metal from its base.

$2Na + Mg(OH)_2 \rightarrow 2NaOH + Mg$

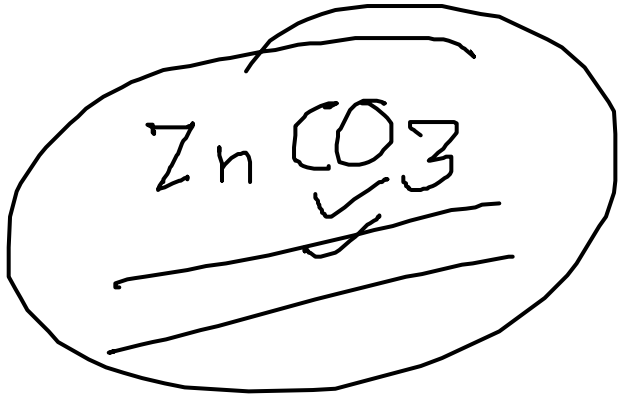
b) Reaction of acids with metal carbonates and bicarbonates

Acid + metal carbonate or bicarbonate → salt + water + carbon dioxide.

$$2HCl + CaCO_3 \rightarrow CaCl_2 + H_2O + CO_2$$

$$H_2SO_4 + Mg(HCO_3)_2 \rightarrow MgSO_4 + 2H_2O + 2CO_2$$

- Effervescence indicates liberation of CO_2 gas.



c) Neutralisation reaction

1. Reaction of metal oxides and hydroxides with acids

Metal oxides or metal hydroxides are basic in nature.

Acid + base → salt + water + heat

$H_2SO_4 + MgO \rightarrow MgSO_4 + H_2O$

$2HCl + Mg(OH)_2 \rightarrow MgCl_2 + 2H_2O$

2. Reaction of non-metal oxides with bases

Non-metal oxides are acidic in nature

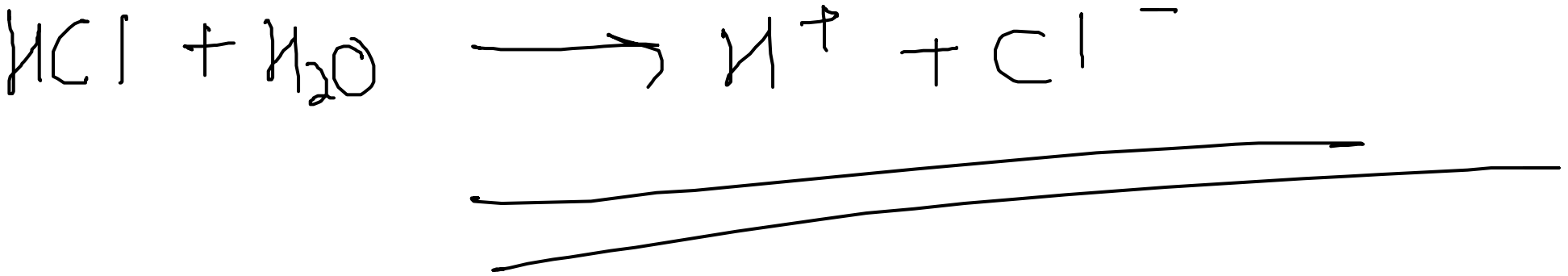
Base + Non-metal oxide → salt + water + heat

$2NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$

- **Acids and bases in water**

- When added to water, acids and bases dissociate into their respective ions and help in conducting electricity.

(New X)



Difference between a base and an alkali

- **Base-** 1. Bases undergo neutralisation reaction with acids.

2. They are comprised of metal oxides, metal hydroxides, metal carbonates and metal bicarbonates.

3. Most of them are insoluble in water.

- **Alkali – 1.** An alkali is an aqueous solution of a base, (mainly metallic hydroxides).

2. It dissolves in water and dissociates to give OH^- ion.

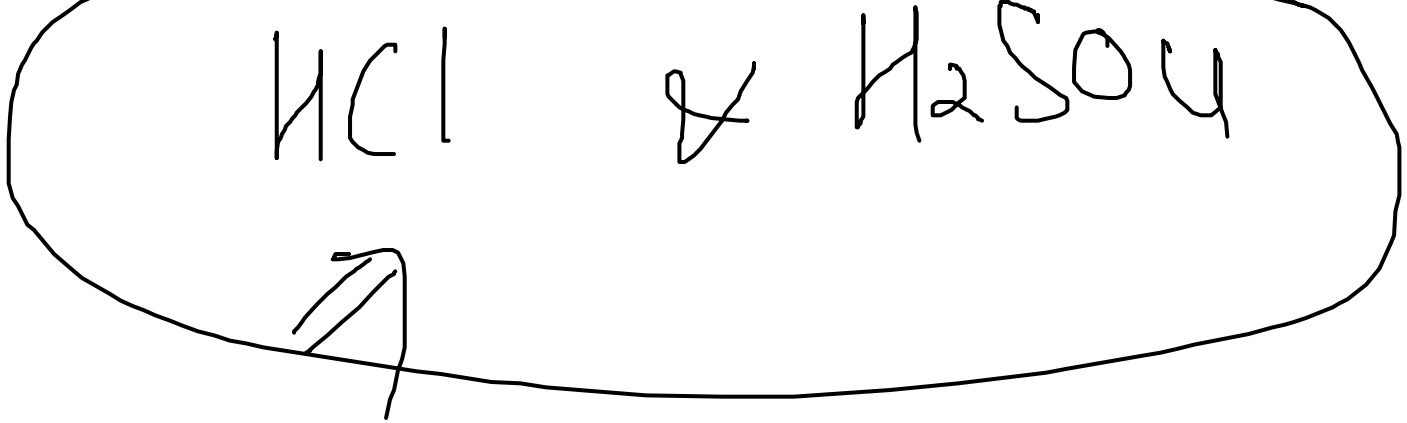
3. All alkalis are bases, but not all bases are alkalis.

- **Dilution**

Dilution is the process of reducing the concentration of a solution by adding more solvent (usually water) to it.

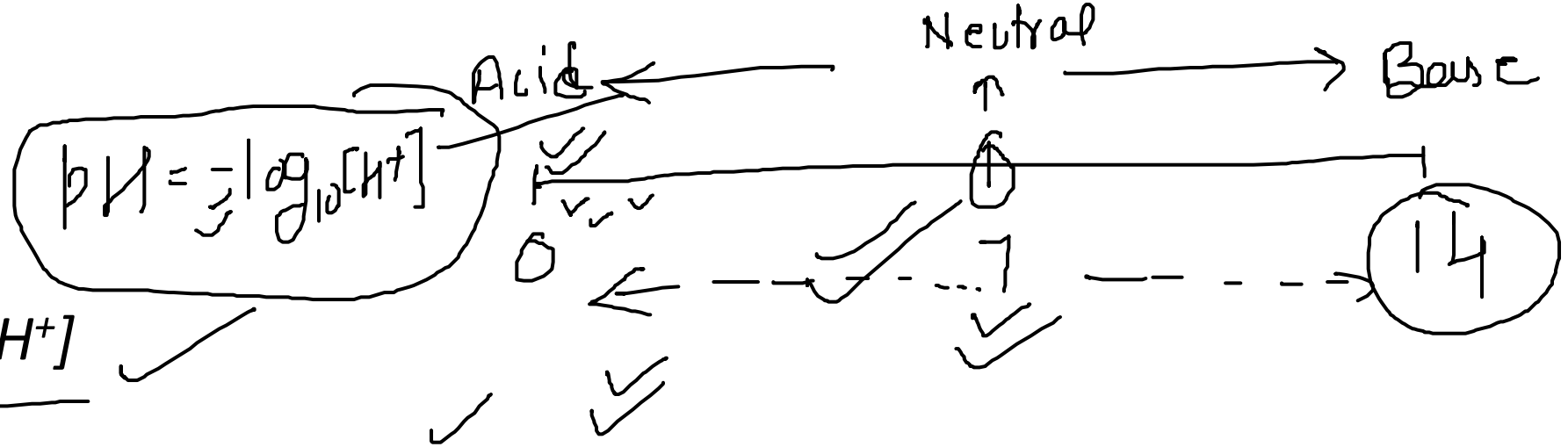
It is a highly exothermic process.

To dilute acid, the acid must be added to water and not the other way round.



- **Universal indicator**
- A universal indicator has a pH range from 0 to 14 that indicates the acidity or alkalinity of a solution.
  A neutral solution has pH=7

- **pH**



$pH=-log_{10}[H^+]$

In pure water, $[H^+]=[OH^-]=10^{-7}$ mol/L. Hence, the pH of pure water is 7.

The pH scale ranges from 0 to 14.

If pH < 7 – acidic solution
If pH > 7- basic solution

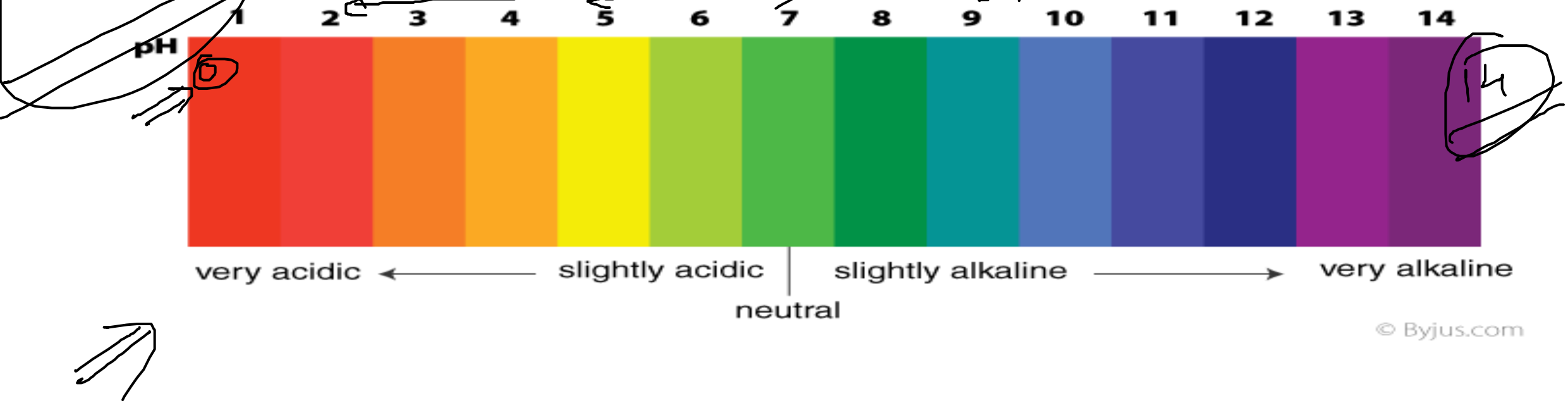
$$pH = \log_{10}\frac{1}{[H^+]}$$

Blood

$pH = \log_{10} \frac{1}{[H^+]}$ ⇒ Comp ⇒ 10^{-7} mol/L

7.3, 7.4

Neutral [H_2O]



Importance of pH in everyday life

1. **pH sensitivity of plants and animals :** Plants and animals are sensitive to pH. Crucial life processes such as digestion of food, functions of enzymes and hormones happen at a certain pH value.

2. **pH of a soil** The pH of a soil optimal for the growth of plants or crops is 6.5 to 7.0.

3. **pH in the digestive system** The process of digestion happens at a specific pH in our stomach which is 1.5 – 4.
The pH of the interaction of enzymes, while food is being digested, is influenced by HCl in our stomach.

⇒ Mucus

- **4. pH in tooth decay** Tooth decay happens when the teeth are exposed to an acidic environment of pH 5.5 and below.

- **5. pH of self-defence by animals and plants** Acidic substances are used by animals and plants as a self-defence mechanism.

- For example, bee and plants like nettle secrete a highly acidic substance for self-defence.

- These secreted acidic substances have a specific pH.

Salts

Acid + Base → Salt

NaCl → Na^+ Cl^-

Na^+ → cation

Cl^- → Anion

- Salts: A salt is a combination of an anion of an acid and a cation of a base. Examples – KCl, $NaNO_3$, $CaSO_4$, etc.

- Salts are usually prepared by the neutralisation reaction of an acid and a base.

$$HCl + NaOH \longrightarrow NaCl + H_2O$$

- **Common salt:** Sodium Chloride (NaCl) is referred to as common salt because it's used all over the world for cooking.

- **Family of salts :** Salts having the same cation or anion belong to the same family. For example, NaCl, KCl, LiCl.

① Basic Salt ⇒ 1 cation & 1 Anion

⇒ e.g:- $NaCl$, KCl, $LiCl$

② Double Salt ⇒ more than 1 cation & Anion

e.g:- $[K_2SO_4, Al_2(SO_4)_3]$

③ Mixed Salt:- 1 cation & 2 Anion

$MgCl_2$

- **pH of salts**

- A salt of a strong acid and a strong base will be neutral in nature. pH = 7 (approx.).

- A salt of a weak acid and a strong base will be basic in nature. pH > 7.

- A salt of a strong acid and a weak base will be acidic in nature. pH < 7.

- The pH of a salt of a weak acid and a weak base is determined by conducting a pH test.

- **Sodium hydroxide**

Chemical formula – NaOH

Also known as – caustic soda

⇒ $NaHCO_3$ ⇒ Sodium Bicarbonate ⇒ Baking Soda

⇒ $Na_2CO_3 \cdot 10H_2O$ ⇒ Sodium Carbonate ⇒ Washing Soda

⇒ NaCl ⇒ Sodium Chloride ⇒ Common Salt

⇒ Table Salt

⇒

- **Bleaching powder**

Chemical formula – $Ca(OCl)Cl$ or $CaOCl_2$

⇒ $MgSO_4$ ⇒ Magnesium Sulphate ⇒ [Rock Salt]
↳ [epsum salt] ↓ gel.

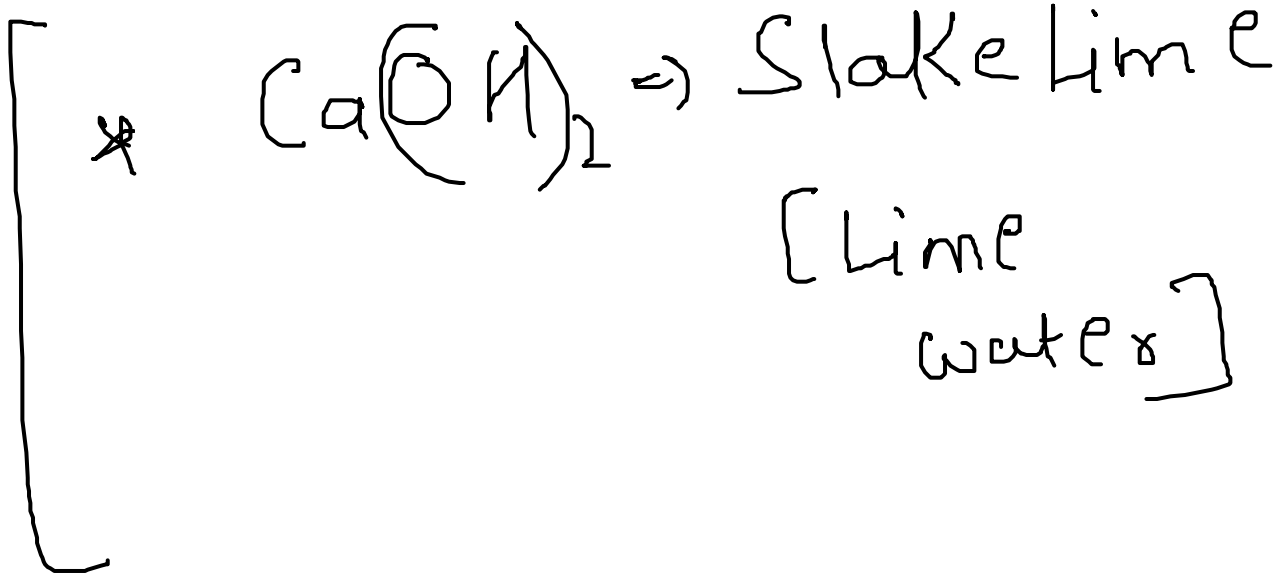
⇒ $Mg(OH)_2$ ⇒ Mag. Hydroxide [Milk of magnesia]

- # Baking soda

Chemical name – Sodium hydrogen carbonate

Chemical formula – $NaHCO_3$

- **Uses:**
  1. Textile industry
  2. Paper industry
  3. Disinfectant



- # Washing soda

Chemical name – Sodium carbonate deca hydrate

Chemical formula – $Na_2CO_3.10H_2O$

- **Uses**
  1. In glass, soap and paper industries
  2. Softening of water
  3. Domestic cleaner

- **Crystals of salts** Certain salts form crystals by combining with a definite proportion of water. The water that combines with the salt is called water of crystallisation.

- Plaster of paris

- Gypsum, $CaSO_4.2H_2O$ (s) on heating at 100°C (373K) gives $CaSO_4$. ½ H_2O and 3/2 H_2O

- $CaSO_4$. ½ H_2O is plaster of paris.

- $CaSO_4$. ½ H_2O means two formula units of $CaSO_4$ share one molecule of water.

- **Uses** – cast for healing fractures.

➢ [KEY POINTS]

- Acid is a compound which yields hydrogen ion (H+), when dissolved in water.

- Acid is sour to the taste and corrosive in nature. The pH value for acids is less than 7.

- Generally, all acids readily react with metal to release hydrogen gas. For example, metal zinc reacts with hydrochloric acid to form zinc chloride and hydrogen gas.

- Acid react with limestone ($CaCO_3$) to produce carbon dioxide. For example, hydrochloric acid reacts with limestone to produce carbonic acid and calcium chloride.

- Acid can be classified in organic and inorganic acids. Acetic acid (CH3COOH) is the best example of organic acid, while acid produced from minerals are termed as inorganic acids like sulfuric acid (H2SO4), hydrochloric acid (HCl).

- Acid converts blue litmus paper to red in color.

- Acids have tendency to corrode metal surface quickly.

- Acids and bases conduct electricity because they produce ions in water. There is a flow of electric current through the solution by ions.

- Indicators are those chemical substances which behave differently in acidic and basic medium and help in determining the chemical nature of the substance.

- Acid base indicators indicate the presence of an acid or a base by a change in their colour or smell.

- Indicators can be natural or synthetic.

•**Olfactory indicators:** These are those indicators whose odour changes in acidic or basic medium.

Onion : Smell of onion diminishes in a base and remains as it is in an acid.

Vanilla: The odour of vanilla essence disappears when it is added to a base. The odour of vanilla essence persists when it is added to an acid.

Turmeric: In acids, yellow colour of turmeric remains yellow. In bases, yellow colour of turmeric turns red.

• Living organisms are pH sensitive. Human body works within a pH range of 7.0 to 7.8.

• Rain water with a pH less than 5.6 is called acid rain. This acid rain if it flows into river water makes the survival of aquatic life difficult.

• Plants also require a specific pH range of soil for their healthy growth.

• pH is also significant as it is used in self defence by animals and plants. Bees use acids in their sting. To neutralise the effect a mild base like baking soda can be used.

• Water of crystallisation: It is the fixed number of water molecules present in one formula unit of
a salt.
• Phenolphthalein solution is colorless in acidic solution and turns methyl orange solution to red.

- Bases are compound which yields hydroxide ion (OH-), when dissolved in water.
- Bases are bitter to taste and corrosive in nature. They feel slippery and soapy.
- Bases are good conductor of electricity and show pH value more than 7.
- Bases react with oils and grease to form soap molecules.
- Bases convert red litmus paper to blue in color.
- Bases also have the tendency to corrode metal surface.

• A reaction between a base and a metal is similar as for acid to form salt and release hydrogen gas. But this reaction can only occur when a metal is strong enough to displace another metal from its parent constituent.
$2NaOH + Zn \rightarrow Na2ZnO2 + H2$

• Phenolphthalein solution turns pink in color in basic solution. Bases turn methyl orange to yellow.

Red cabbage juice which is purple in color changes to yellow in basic medium.

- A salt is defined as a compound formed by the complete or incomplete replacement of the hydrogen ion of an acid by a basic radical.

- A normal salt is formed by the **complete** replacement of the hydrogen ion of an acid by a basic radical whereas an **acid** salt is formed by the **incomplete** replacement of the hydrogen ion of an acid by a basic radical.

- Phenolphthalein solution turns pink in color in basic solution. Bases turn methyl orange to yellow.

• A normal salt is formed by the **complete** replacement of the hydrogen ion of an acid by a basic radical whereas an **acid** salt is formed by the **incomplete** replacement of the hydrogen ion of an acid by a basic radical.

* Please
Stop
calling
Me
A
careless
Zebra
instead
Try
Learning
How
copper

Saves
Gold

$[CaSO_4 \cdot 2H_2O]$

$\Rightarrow [CaSO_4 \cdot \frac{1}{2}H_2O]$

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