25/6/25
Wednesday

Chem. | Ch-2

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ACIDS, BASES, SALTS

* All alkalis are bases, but all bases are not alkalis

Acids	Bases
1. Acids are sour in taste.	1. Bases are bitter in taste
2. Turn blue litmus to red	2. Turn red litmus to blue
3. Furnish H^+ ions when reacted with water.	3. Furnish OH^- ions when reacted with water.
4. pH range : 0 – 7 (6.9)	4. pH range: 7 (7.1) – 14
5. Corrosive in nature	5. Corrosive in nature
6. Contain hydrogen ions and produce H^+ ions in aqueous solution.	6. Contain hydroxide ions and produce OH^- ions in aqueous solution.
7. Soluble in water	7. Some soluble (ALKALIS)*, Some insoluble in water
8. Good electrolytes	8. Good electrolytes
9. Generally solid / liquid at room temperature.	

Acids

- Depending on strength
  - »» strong acid
  - »» weak acid
- Depending on sources
  - »» organic acid
  - »» inorganic acid
- Depending on Concentrations
  - »» Concentrated
  - »» dilute

Depending on strength

1. Strong acids

»» Ionise completely in aqueous solution

»» Produce large number of Hydronium Ions.

» Eg - HCl (Hydrochloric acid)
H_2SO_4 (Sulphuric acid)
HNO_3 (nitric acid)
» Only ions are present - complete dissassociation
$H^+ + H_2O \rightarrow H_3O^+$ (hydronium ions)

2. Weak acids

» Ionise partially in aqueous solution
» Produce small / lesser no. of hydronium ions
» Show lesser degree of Disassociation.
» Ions and molecules both are present.
» Eg - CH_3COOH [Acetic acid (Vinegar)]
HCOOH [Formic acid / Methanoic acid]

Depending on Sources

1. Organic acid

» Those which are obtained naturally from plants and animals.
» They are weak acids and do not ionise completely. ↓ Hence
» Contain ions and disassociated molecules in the solution.
» Eg - CH_3COOH [Acetic acid / Vinegar]
$(COOH)_2$ [Oxalic acid]

2. Inorganic acid

» Not present in nature
» Ranges from strong acids like HNO_3, HCl to weak acids like H_2SO_3 (sulphurous acid).

Depending on Concentration

1. Concentrated acid

- Large amount of acid present in the solution in fixed amounts.
- More acid, little water

2. Dilute acid

- Small amount of acid present in the solution
- Less acid, more water

CHEMICAL PROPERTIES OF ACIDS

1. Reaction with Active Metals

K ↑
Na
Ca
Mg
Al
Zn
Fe
Pb
Sn
[H]
Cu
Hg
Ag
Au
Pt

Metal + Acid → Salt + Hydrogen ↑

Eg - $Mg + H_2SO_4 \longrightarrow MgSO_4 + H_2\uparrow$

$Fe + 2HCl \longrightarrow FeCl_2 + H_2\uparrow$

Note: H_2 gas is not evolved when metal reacts with Nitric ~~acit~~ acid (HNO_3) because HNO_3 is a Strong oxidising agent, so it oxides the hydrogen (H_2) produced to water (H_2O). HNO_3 itself gets reduced to any of the nitrogen oxides (NO_2 / NO / N_2O)

Eg: $Cu + 4HNO_3 \longrightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$

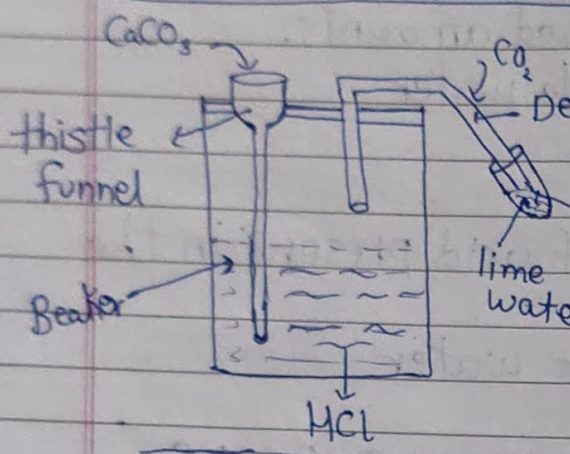
Exception: Mg and Mn react with very dil. HNO_3 to produce H_2 gas.

Eg: $Mg + 2HNO_3 \longrightarrow Mg(NO_3)_2 + H_2\uparrow$

2. Metal Carbonates & Metal bicarbonates (hydrogen carbonates)

Metal Carbonates / Metal bicarbonates + Acid → Salt + H_2O + CO_2

brisk effervescence



METAL CARBONATES

$$CaCO_3\ (s) + 2HCl\ (aq) \longrightarrow CaCl_2\ (aq) + H_2O\ (l) + CO_2\uparrow\ (g)$$

Other examples

$$ZnCO_3 + H_2SO_4 \longrightarrow ZnSO_4 + H_2O + CO_2\uparrow$$

$$FeCO_3\ (s) + H_2SO_4\ (aq) \longrightarrow FeSO_4\ (aq) + H_2O\ (l) + CO_2\uparrow\ (g)$$

METAL BICARBONATES

Eg - $Ca(HCO_3)_2 + HCl \longrightarrow CaCl_2 + H_2O + CO_2\uparrow$

»» Test for CO_2 gas

- $Na_2CO_3\ (s) + 2HCl\ (aq) \longrightarrow 2NaCl\ (aq) + H_2O\ (l) + CO_2\uparrow\ (g)$ (brisk effervescence)

[Sodium carborate] [Hydrochloric acid] [Sodium chloride] [Water] [Carbon dioxide]

»» On passing CO_2 through lime water it will turn milky, showing that the gas is CO_2.

»» If excess CO_2 is passed through lime water.

milkiness disappears and the solution become clear due to the formation of soluble calcium bicarbonate.

Eq^{n} → $Ca(OH)_2 + CO_2 \longrightarrow CaCO_3 + H_2O$
[lime water] [Carbon dioxide] [calcium carbonate] (milky) [water]

$CaCO_3 + H_2O + CO_2 \longrightarrow Ca(HCO_3)_2$
(Excess) [Calcium bicarbonate] (soluble)

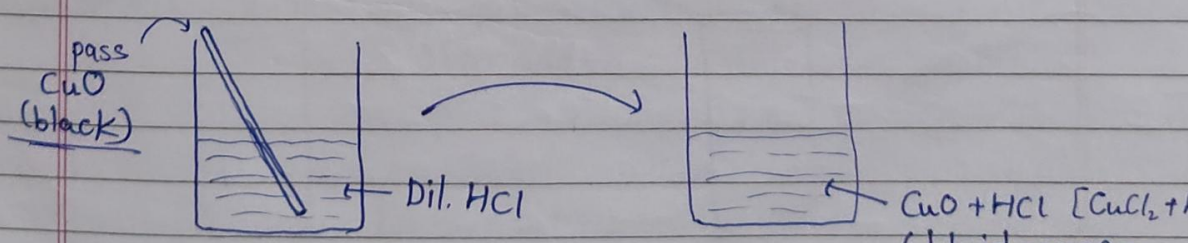
Note: Calcium carbonate is the main constituent of chalk / marble / limestone / egg shell.

3. Reaction with Metal oxides

Metal oxide + Acid → Salt + Water

Metal oxides – generally basic in nature

⋙ $CuO + 2HCl \longrightarrow CuCl_2 + H_2O$
[copper oxide] (s) [hydrochloric acid] (aq) [copper chloride] (aq) [water] (l)



Other Example:
⋙ $MgO + 2HCl \rightarrow MgCl_2 + H_2O$

Exception – Al_2O_3 , ZnO , PbO

↓ Nature

Amphoteric oxides

↓

They behave like acids when they are with bases and behave like bases when they are with acids

Q Compounds like alcohol and glucose also contain hydrogen but are not categorised as acids. Why?

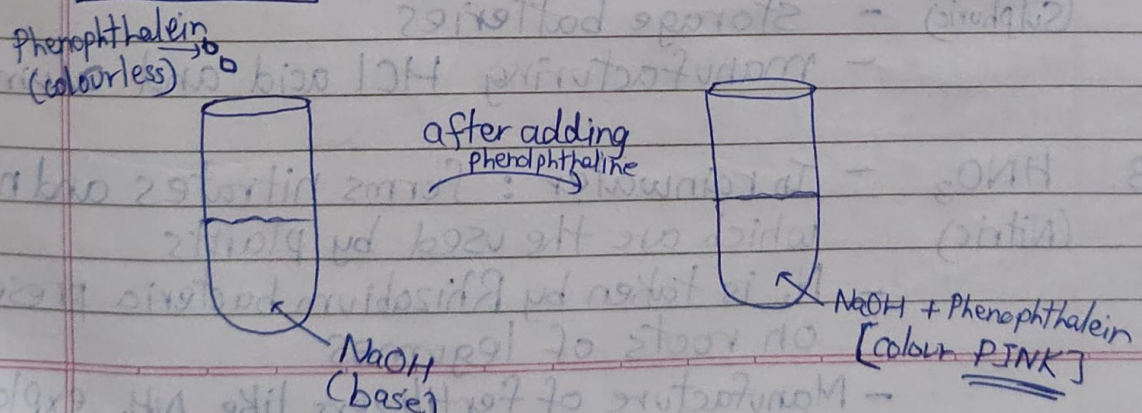
»» Acids are those which conduct electricity because of hydrogen ions produced by them. Hence, although $C_6H_{12}O_6$ and CH_3COOH have hydrogen in them, they are not considered as acids as they don't give H_2 ions in water.

4. Reaction with Base (Neutralisation Reaction)

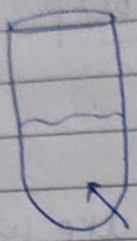
Acid + Base ⟶ Salt + Water

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

Activity ⟹

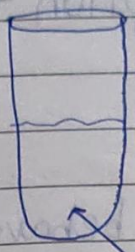


dil. HCl →



NaOH + Phenolphthalein
(pink)

after adding HCl (acid)



[Colour – COLOURLESS]

NaOH + Phenolphthalein + HCl

(base)

Phenolphthaline

Acid	Base
colourless	Pink
Indicator	

1. Take sodium hydroxide in a test tube.
2. Add few drops of phenolphthaline (indicator)
3. Colour changes to pink.
4. Add HCl (acid)
5. ~~Colour~~ Becomes Colourless.

Q Why does dry HCl gas not change the colour of dry litmus paper?

>>> Because it doesn't contain H^+ ions. Acids only produce H^+ ions when water is present.

USES OF ACIDS

1. HCl – manufacturing PVC (PolyVinyl chloride)

2. H_2SO_4 (Sulphuric) – manufacture of detergent & artificial fibres
   – storage batteries
   – manufacturing HCl acid and alum

3. HNO_3 (Nitric) – In rainwater : forms nitrates and nitrites which are the used by plants
   – N_2 is taken by Rhizobium bacteria present on roots of legumes
   – Manufacture of fertilizers like NH_3, explosives

4. H_3BO_3 (Boric) – glass, enamels, leather, paper, explosives
- Preservative for grains
- Detergents

Base ⇌

↓ Insoluble in water

Eg: CuO, $Cu(OH)_2$, $Fe(OH)_3$, $Al(OH)_3$

↓ soluble in water "Alkali"

Eg: Al_2O_3, ZnO } Amphoteric in nature

Characteristics of Bases

- Highly corrosive in nature
- Bitter in taste
- Soapy to touch
- Bases in aqueous solution conduct electricity
- Turns red litmus blue
- When reacted with water, releases OH^- ions.

Examples of Bases

- Sodium hydroxide (NaOH)
- Potassium hydroxide (KOH)
- Calcium hydroxide (CaOH)
- Alkaline batteries
- Soaps
- Bath products
- Sugar
- Baking Soda
- Lubricating greese
- Mouth wash

Uses of Bases

1. KOH (Caustic Potash) — manufacturing soap
   - absorbing CO_2 gas
   - storage batteries

2. $Ca(OH)_2$ (Slaked lime) — manufacturing bleaching powder
   - Softening hard water

3. $Al(OH)_3$ — foaming agent in fire extinguishers

4. $NaOH$ (Caustic Soda) — Manufacture of soap, paper, pulp, refining of petroleum

5. $Mg(OH)_2$ (Milk of Magnesia) — As laxatives, antacids

6. NH_4OH (Ammonium hydroxide)
   - Cleaning window panes
   - Removing greases
   - Removing stains from clothes
   - Used as fertilizers

Phenophthaline →

Acid	Base
colourless	Pink

Phenophthaline

NaOH (base)

∴ Colour after adding phenophthaline = PINK

Bases Reactions

1. Reaction with Metals

Metal + Base ⟶ Salt + Hydrogen

»» ~~Mg~~ + Al + NaOH → $NaAlO_2$ (sodium alumirate) + H_2

»» Zn + 2NaOH ⟶ Na_2ZnO_2 + H_2
(sodium zincate)

2. Reaction with non-metal oxide

Non-metal oxide + Base ⟶ Salt + Water

acidic in nature

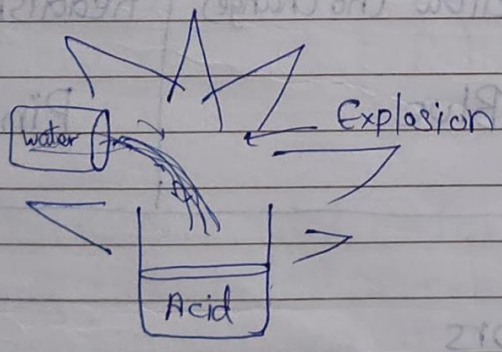
»» CO_2 + $Ca(OH)_2$ ⟶ $CaCO_3$ + H_2O

3. Reaction with Acids

Base + Acid ⟶ Salt + Water

»» NaOH + HCl → NaCl + H_2O

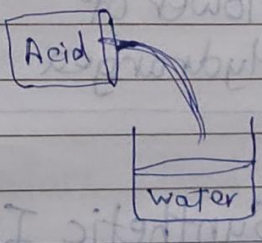
(✗)



Exothermic

Large amounts of heat

(✓) Important thing to consider while experimenting



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INDICATORS

1. Natural Indicators
2. Synthetic Indicators
3. Olfactory Indicators
4. Universal Indicators
5. pH Scale

① Natural Indicators

- Found in nature in the plants
- Eg – Litmus solution is a purple coloured dye extracted from lichens

Indicators	Colour in acidic medium	Colour in basic medium
Litmus	Red	Blue
Red Cabbage juice	Red	Green
Turmeric juice	Yellow (no change)	Reddish brown
Flower of Hydrangea	Blue	Pink

② Synthetic Indicators

- The indicators which are synthesised in laboratories or industries

>>>

Indicator	Colour in acidic solution	Colour in basic solution	Colour in neutral solution
Methyl orange	Red	Yellow	Orange
Phenolphthaline	Colourless	Pink	Colourless

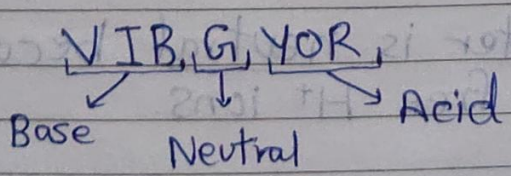
③ Olfactory Indicators

»» Substances whose odour changes in acidic and basic medium

Indicators	Smell in acidic medium	Smell in basic medium
Onion	Retains smell	No smell
Vanilla essence	Retains smell	No smell
Clove oil	Retains smell	No smell

④ Universal Indicator

»» Mixture of several indicators used to judge how strong a given acid or a base is.



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⑤ pH Scale

» Scale used for measuring hydrogen ions concentration

OR

» used for examining the nature of solution

pH

potenz — Hydrogen ions

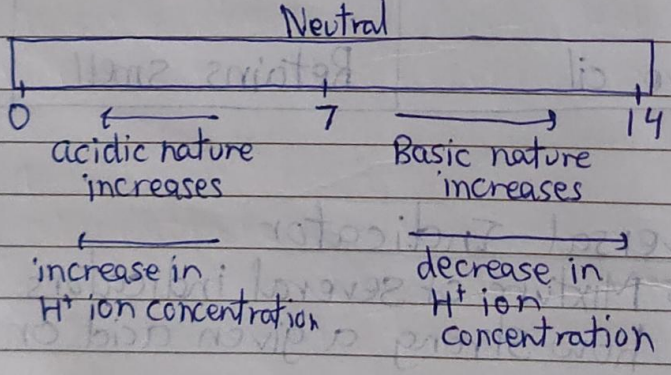
German word

└ Meaning : Power / Potential

∴ pH = Power / Potential of Hydrogen

» Has values from 0 (very acidic) to 14 (very alkaline).

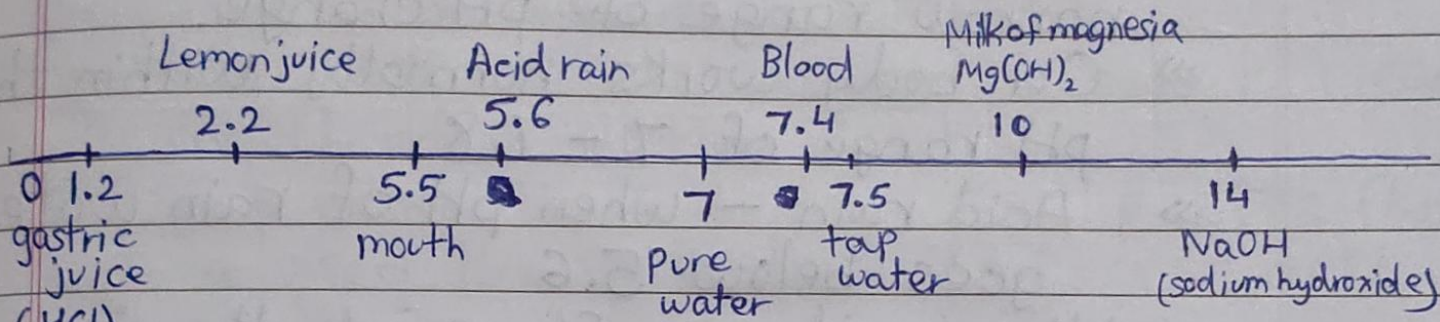
» Higher the hydronium ion concentration present in the solution, lower is its pH value.



» Pure water is neutral because there are no free H^+ ions.

» pH range of soil for healthy growth of plants should be → 5.5 - 7

» If soil is very acidic, then a base [like CaO - Calcium oxide - Quick lime] is added, and vice versa.



Q 5 solutions show pH of 4, 1, 11, 7, 9. Arrange pH in increasing order of H^+ ion concentration.

» 11 → 9 → 7 → 4 → 1

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Importance of pH in everyday life

1. **Plants and Animals are pH ~~in Ever~~ sensitive**
   - Living organisms can survive only a narrow range of pH change.
   - Our body works normally within the pH range of 7 - 7.8.
   - Acid rain - when pH of rain water goes below 5.6
   - When acid rain flows into the river, it lowers the pH of the river water and makes survival of aquatic life difficult.

2. **pH in our Digestive System**
   - HCl present in the stomach helps in digestion of food.
   - During indigestion, the stomach produces too much acid - causes pain, irritation
   - To correct the disturbed pH range, milk of magnesia (a mild base) is used as a medicine which is also called antacid, as it reduces the effect of acid.

3. **Acid on other Planets**
   - The atmosphere of Venus is made up of thick white and yellowish clouds of H_2SO_4 (sulphuric acid), does not support life.

4. **pH change leads to tooth decay**
   - Tooth enamel is made up of calcium phosphate and is the hardest substance in the body.
   - If the pH inside the mouth decreases

to below 5.5 (acidic), the decay of tooth enamel begins.

» This happens when the bacteria present in the mouth works on the leftover food particles and produce acid.

» The best way to prevent this is to clean mouth after eating food.

» To prevent tooth decay, toothpastes (basic) are used to neutralize the excess acid.

5. Self defence by Animals and Plants.

» When insects like honeybee, ant, etc. bite, they inject an acid into the skin that causes pain and irritation.

» If a mild base like baking soda is applied on the affected area, it gives relief.

Note: Nettle leaves produce methanoic acid
Remedy - Dock plant leaves (neutralize)

6. pH of soil

» Plants require specific pH range for healthy growth.

» Ideal pH range - between 5.5 and 7.0

NEUTRILIZATION REACTION

* Acid + Base ⟶ Salt + Water *

① Strong acid + Strong Base ⟶ Neutral Salt + Water

- $HCl + NaOH \longrightarrow NaCl + H_2O$
- $H_2SO_4 + NaOH \longrightarrow Na_2SO_4 + H_2O$

② Strong acid + Weak Base ⟶ Acidic Salt + Water

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

③ Weak acid + Strong base ⟶ Basic salt + Water

- $H_2CO_3 + KOH \longrightarrow K_2CO_3 + H_2O$

④ Weak acid + Weak Base ⟶ Netral Salt + Water

~~$NH_3OH + CH_3COOH \longrightarrow NH_5C_2H_3$~~

- $NH_3OH + CH_3COOH \longrightarrow CH_3CONHOH + H_2O$

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SALTS - A substance formed by neutralization of an acid and a base.

» Ionic compounds

+ve (Cations) | -ve (Anions)

» A salt contains positive metal ion and a negative non-metal ion.

SALTS

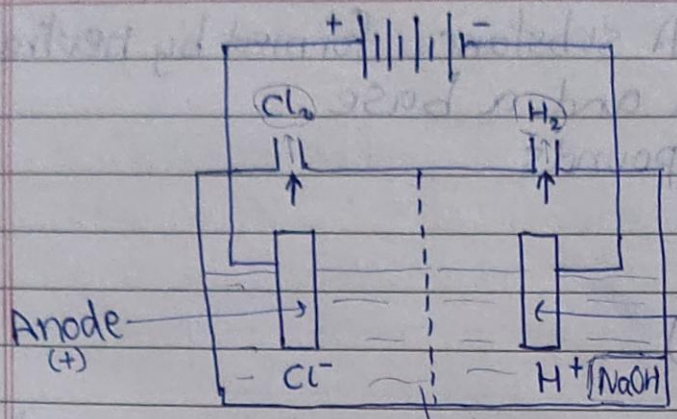
$NaOH$	$CaOCl_2$	$NaHCO_3$	$Na_2CO_3 \cdot 10H_2O$	$CaSO_4 \cdot \frac{1}{2}H_2O$
(sodium hydroxide)	(calcium oxy-chloride)	(Sodium hydrogen carbonate)	(sodium carbonade deca hydrate)	(calcium sulphate hemi hydrate)
Caustic soda	Bleaching powder	Baking Soda	Washing Soda	Plaster of Paris

1. Caustic Soda ($NaOH$) : Sodium Hydroxide

Chloro - Alkali process

» When electric current is passed through aqueous solution of $NaCl$ (Brine), it decomposes to form $NaOH$.

$$2NaCl_{(aq)} + 2H_2O_{(l)} \xrightarrow{\text{electric current}} 2NaOH_{(aq)} + Cl_2\uparrow_{(g)} + H_2\uparrow_{(g)}$$



USES of the products

At Cathode → Hydrogen (H_2)

- fuels
- margarine (by hydrogenation)
- Ammonia (NH_3) for fertilizers
  $N_2 + H_2 \rightarrow NH_3$

At Anode → Chlorine (Cl_2)

- water treatment
- Disinfectant
- Swimming pools
- CFC
- PVC
- Pesticides
- chloro-floro carbons

Near Cathode (Base) → NaOH (sodium hydroxide)

- greasing metals
- Soaps
- Detergents
- Paper making
- Artificial fibres

2. Bleaching powder ($CaOCl_2$) : Calcium oxy chloride

»» It is produced by the action of chlorine on slaked lime (dry).

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Preparation:

$$Ca(OH)_2 + Cl_2 \xrightarrow{313\,K} \underset{\text{(yellow powder)}}{CaOCl_2} + H_2O$$

USES

1. For bleaching purposes in industry, laundry and for preparing chloroform. ($CHCl_3$).
2. As a disinfectant in water to make it germ-free.
3. As an oxidising agent in many chemical industries.

QUES. RELATED TO THIS TOPIC

Q A gas 'X' reacts with lime water and forms a compound 'Y' which is used as a bleaching agent in chemical industry.

»» X = Chlorine
Y = Calcium Oxychloride

Q Name a substance which on treatment with chlorine gives bleaching powder.

»» Calcium hydroxide / Slaked lime

Q A calcium compound, yellow in colour, is used as a disinfectant and in textile industry. Name it.

»» Calcium oxychloride ($CaOCl_2$) / Bleaching powder

Q Which gas is released when $CaOCl_2$ is exposed to air?

»» $CaOCl_2 + CO_2 \longrightarrow CaCO_3 + \underset{(g)}{Cl_2}\uparrow$ ∴ Chlorine

3. Baking Soda ($NaHCO_3$) : Sodium bicarbonate

»» Mild, non-corrosive base

Production:

$$\underset{\text{Sodium chloride}}{NaCl} + \underset{\text{Water}}{H_2O} + \underset{\text{Carbon dioxide}}{CO_2} + \underset{\text{Ammonia}}{NH_3} \longrightarrow \underset{\text{Ammonium chloride}}{NH_4Cl} + \underset{\text{Sodium bicarbonate}}{NaHCO_3}$$

»» When it is heated during cooking, it produces Sodium carbonate, water, carbon dioxide which makes pakoras crispy and tasty.

USES

1. For making baking powder, which is a mixture of baking soda and mild edible acid such as Tartaric acid. (Baking soda + mild edible acid = Baking powder)

   $NaHCO_3 + \underset{\text{(From any acid)}}{H^+} \longrightarrow CO_2 + H_2O + \underset{\text{Salt of acid}}{\text{Sodium}}$

   - Here, CO_2 is produced during the reaction and causes breads or cakes to rise, making them soft and spongy.

2. As an Antacid - being alkaline, it »»

neutralises excess acid in the stomach and provides relief.

3. Used as Soda-Ash Fire Extinguisher

4. **Washing Soda ($Na_2CO_3 \cdot 10H_2O$): Sodium carbonate decahydrate**

Preparation:

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

(Baking soda) — (Na_2CO_3: Sodium carbonate)

$$Na_2CO_3 + 10H_2O \longrightarrow Na_2CO_3 \cdot 10H_2O$$

(hydrated salt) — sodium carbonate deca-hydrate

Q Name the raw materials used

⇒
1. NaCl (sodium chloride)
2. $CaCO_3$ (calcium carbonate)
3. NH_3 (ammonia)

Detailed Preparation:

Step 1 : $NaCl_{(aq)} + H_2O_{(l)} + CO_{2(g)} + NH_{3(g)} \longrightarrow NH_4Cl_{(aq)} + NaHCO_{3(aq)}$

[CO_2 is obtained by heating limestone ($CaCO_3$)]

$$CaCO_3 \xrightarrow{\Delta} CaO + CO_2$$

Step 2: Dry sodium hydrogen carbonate ($NaHCO_3$) is heated strongly to give sodium carbonate.

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

(s) — [anhydrous sodium carbonate - Soda Ash]

Step 3: Sodium carbonate is recrystallized by dissolving in water to get washing soda – a basic salt

$$Na_2CO_3 + 10H_2O \longrightarrow Na_2CO_3 \cdot 10H_2O$$

USES:

1. It is used in glass, paper, soap industry
2. For manufacturing of Borax
3. To remove permanent hardness of water
4. As a cleansing agent in houses and factories (detergent)

5. Plaster of Paris / POP ($CaSO_4 \cdot \frac{1}{2}H_2O$): Calcium Sulphate hemi-hydrate

- White, soft powdered mass
- On wetting with water, it sets into hard mass (Gypsum).

PREPARATION

- Obtained by heating gypsum ($CaSO_4 \cdot 2H_2O$) Calcium sulphate dihydrate
- At 373K temperature, gypsum loses water molecules and forms POP (Plaster of Paris)
- On mixing with water, POP again changes to gypsum and converts into hard, solid mass.

$$\underset{\text{gypsum}}{CaSO_4 \cdot 2H_2O} \xrightarrow[\text{(reversible)}]{373K,\ \Delta} \underset{\text{POP}}{CaSO_4 \cdot \tfrac{1}{2}H_2O} + 1\tfrac{1}{2}H_2O$$

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» When gypsum is heated above 400K, dead burnt PoP is formed which does not have the property of hardening.

USES:
1. Used by doctors for joining fractured bones
2. For making decorative pieces, toys, designs on ceilings

Q PoP should be kept in moisture proof (air tight) containers. Give reason.

» As PoP is white, soft powdered mass, which on absorbing water, gets converted into gypsum (a hard mass).

SALT CRYSTALS

» Many salts combine with water molecules and form crystals. This is known as water of crystallization (the water) / hydrated salts. (the salt formed)

» Salts which do not contain water of crystalization are called anhydrated salts or anhydrous salts (they are often powders)

WATER OF CRYSTALLIZATION

» It is the fixed no. of water molecules present in one formula unit of a salt.

Name	Formula
① Hydrate copper sulphate (Blue Vitrol)	$CuSO_4 \cdot 5H_2O$
② Washing Soda	$Na_2CO_3 \cdot 10H_2O$
③ Gypsum	$CaSO_4 \cdot 2H_2O$
④ Plaster of Paris	$CaSO_4 \cdot \frac{1}{2}H_2O$
⑤ Zinc Sulphate	$ZnSO_4 \cdot 7H_2O$
⑥ Magnesium sulphate	$MgSO_4 \cdot 7H_2O$
⑦ Ferrous Sulphate (pale green colour)	$FeSO_4 \cdot 7H_2O$

* Sulphate family is called Vitrol (Eg: ① Hydrate copper sulphate (Blue vitrol)