# ALKALI METAL

## 1. PHYSICAL STATE

(a) One electron in outermost shell & **General formula $ns^1$**.

(b) Francium is radioactive element.

(c) All are silvery white

(d) Light soft, malleable and ductile metals with metallic lustre.

(e) Alkali metals are paramagnetic, diamagnetic and colourless in form of ions.

## 2. ATOMIC SIZE

(a) Biggest in their respective period

(except noble gas element)

(b) Size increases from Li to Fr due to addition of an extra shell.

$Li < Na < K < Rb < Cs < Fr$

## 3. SOFTNESS

(a) Alkali metals are soft because of -

- (i) Large atomic size
- (ii) BCC crystal structure (HCP in Li)
- (iii) Loose packing (68% packing efficiency)
- (iv) Weak metallic bond

(b) Cs is the softest metal in s-block

$$\boxed{\text{Atomic size} \propto \frac{1}{\text{strength of metallic bond}} \propto \text{softness} \propto \frac{1}{\text{Melting \& Boiling point}}}$$

## 4. MELTING POINT AND BOILING POINT

(a) Weak interatomic bonds are due to their large atomic radii and presence of only one valence electron hence melting point and boiling point are low.

(b) Decreasing order of melting point and boiling point is

$Li > Na > K > Rb > Cs$

(c) With the increase in the size of metal atom, the repulsion of the non-bonding electrons increases and therefore melting point and boiling point decreases from Li to Cs.

## 5. ELECTRO POSITIVE CHARACTER OR METALLIC CHARACTER

**Electropositivity $\propto$ 1/Ionisation Potential**

Due to their larger size electron can easily be removed to form $M^+$ ion. Electro positive property increases from Li to Cs.

## 6. FLAME TEST

Alkali metals and their salts gives characteristic colour to bunsen flame. The flame energy causes an excitation of the outer most electron which on dropping back to ground state emits absorbed energy as visible light

Ex. Li-Crimson red Na-Golden yellow K-Violet

Rb-Red violet Cs-Blue

## 7. REACTION WITH $NH_3$

(a) $2Li + NH_3 \rightarrow Li_2NH$ (Lithimide)

$2Na + 2NH_3 \rightarrow 2NaNH_2 + H_2\uparrow$

(Sodamide)

(b) Solubility in liquid ammonia

(i) All the alkali metals dissolves in $NH_3$ (liq.) and produces blue solution.

(ii) This blue solution conducts electricity and possesses strong reducing power, due to the presence of ammoniated electrons.

$$Na_{(s)} + (x+y)\ NH_3 \rightarrow [Na(NH_3)_x]^+ + \underbrace{[e(NH_3)_y]^-}_{\text{ammoniated electron}}$$

(iii) This dilute solution is paramagnetic in nature.

## 8. PHOTO ELECTRIC EFFECT

(a) Atomic size of K, Rb and Cs is quite large, so their ionisation potential is very low

(b) Due to very low ionisation potential their valence shell electrons gets excited even by absorbing visible light. That's why Cs is used in photo cells.

## 9. STANDARD OXIDATION POTENTIAL

(a) All the alkali metals have high +ve values of standard oxidation potential (tendency of releasing electrons in water or self ionic solutions)

(b) So these are good reducing agent, having upper most positions in the electro chemical series.

(c) Li has highest standerd oxidation potential (+3.05 eV) due to its high hydration energy. Such that it converts into. $Li^+$ ion by loosing one electron.

| Order of standard oxidation potential of s - block element |
|---|
| Li > K > Ba > Sr > Ca > Na > Mg > Be |
| Hydration energy $\propto$ Charge density on ion |

## 10. HYDRATION ENERGY (HEAT OF HYDRATION)

(a) Alkali metals salts are generally soluble in water due to hydration of cations by water molecules.

(b) Smaller the cation, greater is the degree of its hydration.

(c) $$\underset{\xrightarrow{\hspace{6cm}}}{Li^+ \qquad Na^+ \quad K^+ \quad Rb^+ \qquad Cs^+}$$

- * Degree of hydration decreasing
- * Hydration energy decreasing
- * Hydrated ion size decreasing
- * Ionic conductance increasing

## 11. REDUCING PROPERTY

(a) Since alkali metals have high standard oxidation potential, so these are strongest reductants.

(b) Reducing property increases down the group in gaseous or molten state

$$Li^+ < Na^+ < K^+ < Rb^+ < Cs^+$$

(c) But in aqueous solution order is -

$$Li^+ > K^+ \simeq Rb^+ > Cs^+ > Na^+$$

## 12. REACTION WITH AIR

(a) Alkali metals gets turnish in air due to the formation of oxide at their surface hence they are kept in kerosene or paraffin oil.

(b) These elements reacts with moist air to form carbonates

$$4Na + O_2 \rightarrow 2Na_2O$$

$$Na_2O + \underset{\text{(moist)}}{H_2O} \rightarrow 2NaOH$$

$$2NaOH + \underset{\text{(in air)}}{CO_2} \rightarrow Na_2CO_3 + H_2O$$

In dry air only Li gives nitride and oxide both while other elements gives only oxides.

## 13. REACTION WITH OXYGEN

**Oxide ion [$O^{2-}$] :**

Li forms only $Li_2O$ (Lithium oxide).

**Peroxide [$O_2$]$^{-2}$ :**

Na reacts with $O_2$ to form peroxide ($Na_2O_2$).

**Super oxide [$O_2^-$] :**

K, Rb and Cs forms $MO_2$ type oxides (super oxides) in excess of $O_2$. So super oxides are paramagnetic and coloured.

$$M \xrightarrow{O_2} \underset{\text{Oxide}}{M_2O} \xrightarrow{O_2} \underset{\text{perioxide}}{M_2O_2} \xrightarrow{O_2} \underset{\substack{\text{super}\\ \text{oxide}}}{M_2O_2}$$

$(Li_2O)$ $(Na_2O_2)$ $(KO_2, RbO_2, CsO_2)$

**Their stability order is –**

Normaloxide > Peroxide > Superoxide

## 14. REACTION WITH WATER

(a) Alkali metals react vigorously with water forming hydroxides with the liberation of $H_2$.

$$2M + 2H_2O \rightarrow 2MOH + H_2$$

(b) Reactivity with water increases from Li to Cs.

Li → least reactive towards water

Na → reacts vigorously

K → reacts producing a flame

Rb, Cs → reacts explosively.

(c) These metals also reacts with alcohol gives alkoxide and $H_2$.

$$2Li + 2C_2H_5OH \rightarrow 2C_2H_5O^-Li^+ + H_2$$

(d) Monoxides gives strongly alkaline solution with water

$$M_2O + H_2O \rightarrow 2MOH$$

## 15. HALIDES

(a) Alkali metals reacts directly with halogen to form MX

(M – alkalimetal, X – Halide ion)

(b) Ionic properties of MX increases from LiCl to CsCl

(c) LiCl is covalent in nature (due to polarisation of $Cl^-$ ion by small $Li^+$ ion). hence it hydrolyses with water while rest are ionic so do not hydrolyse.

(d) K, Rb and Cs halides reacts with more halogens to gives polyhalides.

$$KI + I_2 \rightarrow KI_3 \xrightarrow[\text{ionisation}]{\text{on}} K^+ + I_3^-$$

$$CsBr + Br_2 \rightarrow CsBr_3 \rightarrow Cs^+ + Br_3^-$$

## 16. CARBONATES

(a) All the alkali metals forms $M_2CO_3$ type carbonates.

(b) Except $Li_2CO_3$, all the carbonates are stable towards heat

$$Li_2CO_3 \xrightarrow{\Delta} Li_2O + CO_2$$

(c) Thermal stability of carbonates $\propto 1/\phi$ (Ionic potential)

Order of stability is –

$$Cs_2CO_3 > Rb_2CO_3 > K_2CO_3 > Na_2CO_3 > Li_2CO_3$$

## 17. NITRATES

(a) Alkali metals forms $MNO_3$ type nitrates (M – alkali metal)

(b) Stability increases from $LiNO_3$ to $CsNO_3$. $LiNO_3$ decompoes into Lithium oxide & $NO_2$ on heating.

$$4LiNO_3 \xrightarrow[\text{Oxide}]{\Delta} 2Li_2O + 4NO_2 + O_2$$

(c) Other nitrates, on heating to give nitrite and oxygen.

$$MNO_3 \xrightarrow{\Delta} \underset{\text{Nitrite}}{2MNO_2} + O_2$$

## 18. NITRIDES

Only Li reacts directly with $N_2$ to form nitride which gives $NH_3$ on reacting with water.

$$6Li + N_2 \rightarrow 2Li_3N$$

$$Li_3N + 3H_2O \rightarrow 3LiOH + NH_3\uparrow$$

## 19. FORMATION OF AMALGAM

(a) Alkali metals gives amalgam with Hg.

(b) These metals reacts with other metals to give mixed metals (alloys)

## 20. SULPHATES

(a) Alkali metals forms $M_2SO_4$ type sulphates.

(b) All alkali metal sulphates are ionic. Ionic properties increases from Li to Cs.

$$Li_2SO_4 < Na_2SO_4 < K_2SO_4 < Rb_2SO_4 < Cs_2SO_4$$

(c) $Li_2SO_4$ Least soluble in water.

(d) These sulphates on burning with C forms sulphides

$$M_2SO_4 + 4C \rightarrow M_2S + 4CO$$

(e) Except lithium, sulphates of IA group reacts with

sulphates of trivalent metals like $Fe^{+3}$, $Cr^{+3}$, $Al^{+3}$ etc. gives double salts called alum.

$$\overset{\text{I}}{M_2}SO_4.\overset{\text{III}}{M_2}(SO_4)_3.24H_2O$$

## 21. REACTION WITH ACIDS

Reacts vigorously with acids.

$$2M + H_2SO_4 \rightarrow M_2SO_4 + H_2\uparrow$$

# COMPOUNDS OF ALKALI METALS

## 1. SODIUM (NA), NATRIUM

(a) **Extraction : Down's Process**

By Electrolysis of fused NaCl + $CaCl_2$ + NaF

At cathode (Iron Vessel) : $Na^+ + e^- \longrightarrow Na(s)$

At Anode (Graphite) : $2Cl^- \longrightarrow Cl_2 + 2e^-$

(i) ($CaCl_2$ + NaF) is used to lower Melting point ($800^0C$) of NaCl to about $600^0C$.

(ii) Aqueous sodium chloride cannot be used for preparing sodium by electrolysis. Because instead of metallic sodium, hydrogen gas will be liberated at cathode.

(b) **Properties**

(i) It is a crystalline soft metal.

(ii) Highly reactive, so kept in kerosene.

(iii) Na dissolves in liquid $NH_3$ to give blue solution.

(c) **Uses**

(i) In the preparation of sodium amalgam (used as reducing agent)

(ii) In sodium vapour lamp, which emits monochromatic yellow light.

(iii) As heat transfer medium in nuclear reactors.

## 2. SODIUM CHLORIDE NaCl

(a) **Occurrence** : Sea water is the main source and also found in salt lakes.

(b) **Preparation**

(i) Sea water NaCl(2.7 – 2.9%) $\xrightarrow[\text{by solar heat}]{\text{Evaporation}}$ crude NaCl

(ii) It contains impurities – $Na_2SO_4$, $MgCl_2$, $CaCl_2$ etc.

(iii) Insoluble impurities removed by filtration.

(iv) Filtrate $\xrightarrow{\text{HCl gas passed}}$ Pure NaCl precipitation (Common ion effect)

$HCl \rightleftharpoons H^+ + Cl^-$ $\qquad$ $NaCl \rightleftharpoons Na^+ + Cl^-$

Ionic product of $[Na^+]$ $[Cl^-]$ > solubility product of NaCl hence it precipitates out.

(v) $MgCl_2$ and $CaCl_2$ are more soluble in water so left in solution.

(c) **Properties**

(i) Table salt is slightly hygroscopic due to the presence of magnesium and calcium chlorides in small amounts.

(ii) Reaction with $AgNO_3$

$NaCl + AgNO_3 \rightarrow NaNO_3 + AgCl$(white ppt.)

Reaction with $K_2Cr_2O_7$ + conc. $H_2SO_4$

(iii) $4NaCl + K_2Cr_2O_7 + 5H_2SO_4 \xrightarrow{\Delta} 4NaHSO_4 + K_2SO_4 + 2CrO_2Cl_2 + 3H_2O$

(orange red)

(d) **Uses**

(i) As a preservative for pickles, meat and fish.

(ii) For making freezing mixture with Ice.

## 3. SODIUM HYDROXIDE (NaOH), CAUSTIC SODA

(a) **Manufacture** : By electrolysis of NaCl.

(b) **Nelson Cell or Diaphragm Cell** : The following reactions takes place –

$$\left.\begin{array}{l} NaCl(aq.) \rightleftharpoons Na^+ + Cl^- \\ H_2O \rightleftharpoons H^+ + OH^- \end{array}\right\} \rightarrow NaOH + H_2 + Cl_2$$

At cathode (Perforated steel) : $2H^+ + 2e^- \rightarrow H_2(g)$ At anode (Carbon) : $2Cl^-(aq.) \rightarrow Cl_2(g) + 2e^-$

(c) **Castner – Kellner Cell** : (Hg – Cathode Process)

Electrolite (Brine) $NaCl \rightleftharpoons Na^+ + Cl^-$

**On electrolysis –**

At Cathode (Hg)

$Na^+ + e^- \rightarrow Na.$ and $Na + Hg \rightarrow Na.Hg$ (amalgum)

At anode (Graphite)

$2Cl^- \rightarrow Cl_2(g) + 2e^-$ and $2Na.Hg + 2H_2O \rightarrow 2NaOH + H_2 + 2Hg$

(d) **Properties**

(i) It is deliquescent white crystalline solid.

(ii) It absorbs $CO_2$ from air forming $Na_2CO_3$.

(iii) NaOH is **strong base**

$$NaOH \xrightarrow{SiO_2} Na_2SiO_3 + H_2O$$
$$NaOH \xrightarrow{Al_2O_3} 2NaAlO_2 + H_2O$$

(iv) **Reaction with non metals** : no reaction with $H_2$, $N_2$ and C

$$NaOH \xrightarrow{B} Na_3BO_3 \text{ (sodium borate)}$$
$$NaOH \xrightarrow{Si} Na_2SiO_3 \text{ (sodium silicate)}$$
$$NaOH \xrightarrow{P_4} NaH_2PO_2 + PH_3$$

(sodium hypo phosphate)

(v) **Reaction with halogens**

$$X_2 \xrightarrow{NaOH\,(cold/dil)} NaX + NaOX \text{ (Sodium hypo halite)}$$
$$X_2 \xrightarrow{NaOH\,(Hot/conc.)} NaX + NaOX_3 \text{ (Sodium Halate)}$$

$(X_2 = Cl_2, Br_2, I_2)$

(vi) **Reaction with Metal :**

$$NaOH \xrightarrow{\text{Alkali metal}} \text{No reaction}$$
$$NaOH \xrightarrow{2Al + 2H_2O} 2NaAlO_2 \text{ (Sodium meta aluminate)} + H_2$$
$$NaOH \xrightarrow{Be} Na_2BeO_2 \text{ (Sodium Berrylate)} + H_2$$
$$NaOH \xrightarrow{Zn} Na_2ZnO_2 \text{ (Sodium zincate)} + H_2$$
$$NaOH \xrightarrow{Sn} Na_2SnO_2 \text{ (Sodium stannite)} + H_2$$
$$NaOH \xrightarrow{Pb} Na_2PbO_2 \text{ (Sodium plumbite)} + H_2$$

(vii) **Reaction with $ZnCl_2$ or $ZnSO_4$**

$$ZnCl_2 + 2NaOH \longrightarrow Zn(OH)_2\downarrow + 2NaCl$$

$$Zn(OH)_2 + 2NaOH \longrightarrow \underset{\text{(Soluble complex )}}{Na_2[Zn(OH)_4]}$$

(viii) The hydroxides of aluminium, zinc, lead and tin, however, dissolve in excess of sodium hydroxide giving clear solution which can also be obtained when these metals are acted upon by the concentrated solution of sodium hydroxide.

$$Zn(OH)_2 + 2OH^- \longrightarrow \underset{\text{Zincate ion}}{[Zn(OH)_4]^{2-}} \qquad Al(OH)_3 + 3OH^- \longrightarrow \underset{\text{Aluminate ion}}{[Al(OH)_6]^{3-}}$$

(e) **Uses**

(i) In the manufacture of soap, rayon, dyes, paper and drugs.

(ii) In petroleum refining.

## 4. SODIUM BICARBONATE OR BAKING SODA ($NaHCO_3$)

(a) **Preparation : Solvay process** (Commercial Scale)

$CaCO_3 \longrightarrow CaO + CO_2$ (In brine saturated with $NH_3$, $CO_2$ is passed)

$NH_3 + H_2O + CO_2 \longrightarrow NH_4HCO_3$

$NaCl + NH_4HCO_3 \longrightarrow NH_4Cl + NaHCO_3$

$2NH_4Cl + CaO \longrightarrow CaCl_2 + 2NH_3 + H_2O$ (Bye-products)

(b) **Properties**

| | |
|---|---|
| **Hydrolysis** | $NaHCO_3 + H_2O \rightleftharpoons NaOH + H_2CO_3$ |
| **Effect of heat** (temp. > 100 C)<br>(Process occurs during preparation of cake) | $2NaHCO_3 \longrightarrow Na_2CO_3 + H_2O + CO_2\uparrow$ |
| **Reaction with acids** – gives $CO_2$ | $NaHCO_3 + HCl \longrightarrow NaCl + H_2O + CO_2\uparrow$ |
| **Reaction with base** | $NaHCO_3 + NaOH \longrightarrow Na_2CO_3 + H_2O$ |

(c) **Uses**

(i) In the preparation of baking powder.

(ii) In the preparation of effervescent drinks.

(iii) In the fire extinguishers.

(iv) As antacid medicine (removing acidity)

## 5. SODIUM CARBONATE OR WASHING SODA ($Na_2CO_3.10H_2O$)

(a) **Occurrence** : $Na_2CO_3$–Soda ash.

(b) **Manufacture : By solvay process**

(i) Concentrated aqueous solution of NaCl is saturated with $NH_3$.

(ii) Current of $CO_2$ passed through the solution.

(iii) $NaHCO_3$ precipitated –

$NH_3 + CO_2 + H_2O \longrightarrow NH_4HCO_3 \rightleftharpoons NH_4^+ + HCO_3^-$

$NaCl \rightleftharpoons Na^+ + Cl^-$

$[Na^+]\ [HCO_3^-] > K_{sp}$ of $NaHCO_3$ **(so ppt. forms)**

$2NaHCO_3 \longrightarrow Na_2CO_3 + H_2O + CO_2$

(iv) Potassium bicarbonate ($KHCO_3$) cannot be prepared by solvay process as it is soluble in water.

(c) **Leblanc Process**

$NaCl + H_2SO_4$ (conc.) $\xrightarrow{\text{mild heating}}$ $NaHSO_3 + HCl$

$NaCl + NaHSO_4 \xrightarrow[\text{heated}]{\text{Strongly}} Na_2SO_4 + HCl$

(Salt Cake)

$Na_2SO_4 + 4C \longrightarrow Na_2S + 4CO\uparrow$

$Na_2S + CaCO_3 \longrightarrow Na_2CO_3 + CaS$

(d) **Properties**

(i) **Efflorescence :**

$Na_2CO_3.10H_2O$ when exposed to air it gives out nine out of ten $H_2O$ molecules.

$Na_2CO_3.10H_2O \longrightarrow Na_2CO_3.H_2O + 9H_2O$

(Monohydrate)

This process is called efflorescence. Hence washing soda losses weight on exposure to air.

(ii) **Hydrolysis** :Aqueous solution of $Na_2CO_3$ is alkaline in nature due to anionic hydrolysis.

$Na_2CO_3 \longrightarrow 2Na^+ + CO_3^{-2}$ and $CO_3^{-2} + H_2O \rightleftharpoons H_2CO_3 + 2OH^-$

(Carbonic acid)

(e) **Uses**

(i) For making fusion mixture ($Na_2CO_3 + K_2CO_3$)

(ii) In the manufacture of glass, caustic soda, soap powders etc.

(iii) In laundries and softening of water.

## 6. SODIUM PEROXIDE $Na_2O_2$

(a) Sodium peroxide is manufacured by heating sodium metal on aluminium trays in air (free from $CO_2$)

$2Na + O_2$ (air) $\longrightarrow Na_2 O_2$

(i) When pure it is colourless, and the faint yellow colour of the usual product arises from the presence of a small amount of $NaO_2$.

(ii) When it is exposed, it comes in contact with moist air and turns white due to formation of NaOH and $Na_2CO_3$. Thus

$Na_2O_2 + 2H_2O \longrightarrow 2NaOH + H_2O_2$ and $2NaOH + CO_2 \longrightarrow Na_2CO_3 + H_2O$

(iii) Sodium peroxide is a powerful oxidizing agent and oxidizes chromium (III) hydroxide to sodium chromate, manganese (II) to sodium manganate and sulphides to sulphates.

$2Cr(OH)_3 + 3O_2^{-2} \longrightarrow CrO_4^{-2} + 2OH^- + 2H_2O$

(b) **Uses**

(i) Sodium peroxide is widely used as an oxidizing agent yielding in inorganic chemisty; its reaction with organic compounds are dangerously violent.

(ii) Sodium readily combines with carbon dioxide, sodium carbonate and oxygen, it may be used for the purification of air in confined spaces such as submarines.

(iii) It is also used as a bleaching agent because of its oxidizing property.

(iv) Sodium peroxide is used in the manufacture of dyes, and many other chemicals such as benzoyl peroxide, sodium perborate etc.

## 7. POTASSIUM HYDROXIDE KOH

(a) **Preparation:** Electrolysis of KCl aqueous solution.

(b) **Properties:** Same as NaOH

(i) It is stronger base compared to NaOH.

(ii) Sollubility in water is more compared to NaOH.

(iii) In alcohol, NaOH is sparingly soluble but KOH is highly soluble.

(iv) As a reagent KOH is less frequently used but in absorption of $CO_2$, KOH is preferable used compared to NaOH. Because $KHCO_3$ formed is soluble whereas $NaHCO_3$ is insoluble and may therefore chocke the tubes of apparatus used.

## 8. POTASSIUM CARBONATE

(a) By leblance process, it can be prepared but by solvay process it cannot be prepared because $KHCO_3$ is soluble in water.

(b) **Properties:** It resembles with $Na_2CO_3$, m.p. is 900°C but a mixture of $Na_2CO_3$ and $K_2CO_3$ melts at 712°C.

(c) **Uses:** It is used in glass manufacturing.

## 9. POTASSIUM CHLORIDE

It is also occurs in nature and sylvyne (KCl) or carnalite ($2KCl.MgCl_2.6H_2O$)

**Uses:** It is used as fertiliser.

## 10. OXIDES OF POTASSIUM

| | $K_2O$, | $K_2O_2$, | $K_2O_3$, | $KO_2$ | $KO_3$ |
|---|---|---|---|---|---|
| **Colours** | White | White | Red | Bright yellow | Reddish brown needles |

**Preparation**

(i) $2KNO_3 + 10K \xrightarrow{\text{heating}} 6K_2O + N_2$

$K_2O \xrightarrow{\text{heating}} K_2O$

(white) (Yellow)

$K_2O + H_2O \longrightarrow 2KOH$

(ii) $2K + O_2 \xrightarrow[\text{air at } 300^\circ C]{\text{Controlled}} K_2O_2$

(iii) Passage of $O_2$ through a blue solution of K in liquid $NH_3$ yields oxides $K_2O_2$ (white), $K_2O_3$ (red) and $KO_2$ (deep yellow) i.e.

$$\text{K in liq. } NH_3 \xrightarrow{O_2} \underset{\text{white}}{K_2O_2} \longrightarrow \underset{\text{red}}{K_2O_3} \longrightarrow \underset{\text{yellow}}{KO_2}$$

$KO_2$ reacts with $H_2O$ and produces $H_2O_2$ and $O_2$ both

$$\underset{\text{(Dry powdered)}}{KOH} + O_3 \text{ (Ozonised oxygen)} \xrightarrow{-10^\circ \text{ to } -15^\circ C} \underset{\text{(orange solid)}}{KO_3}$$

# ALKALINE EARTH METAL

## 1. PHYSICAL STATE

(a) Two electrons in outer most shell & General formula $ns^2$.

(b) Radium is radioactive element.

(c) All are greyish white.

(d) These metals are harder than alkali metals.

(e) These are diamagnetic and colourless in form of ions or in metal states.

## 2. ATOMIC SIZE

Smaller than IA group elements, since extra charge on nucleus attracts the electron cloud.

(a) Size increases gradually from Be to Ba
$Be < Mg < Ca < Sr < Ba$

(b) In s-block elements
Be is the smallest, Cs is the biggest

## 3. SOFTNESS

(a) These metals are slightly harder than IA group because of -
(i) Smaller atomic size
(ii) FCC, HCP crystal structures
(iii) Packing capacity 74%
(iv) Stronger metallic bond due to presence of two electrons in valence shell.
(b) Be is the hardest metal in s-block.

## 4. MELTING POINT AND BOILING POINT

(a) Metallic bond is stronger than IA group due to smaller atomic size and two electrons in valence shell hence melting point and boiling point are higher.

(b) Decreasing order of melting point and boiling point is
$Be > Ca > Sr > Ba > Mg$

(c) Melting point and Boiling point of Ca, Sr and Ba is higher than Mg because of presence of d-orbitals in the outer most shell, which forms stronger metallic bond.

## 5. ELECTRO POSITIVE CHARACTER OR METALLIC CHARACTER

Their atomic size is smaller than IA group so these are lesser electro positive than IA group. Electropositivity increases from Be to Ba

## 6. FLAME TEST

(a) Be and Mg atoms, due to small size, bind their electrons more strongly, so are not excited to higher level, hence no flame test.

(b) Other elements gives characteristic colour to flame

Ca-Brick red Sr-crimson red
Ba-Apple green

## 7. REACTION WITH $NH_3$

(a) On increasing metal ion concentrate solution converts into bronze colour due to cluster formation of metal ions.

(b) Solubility in liquid ammonia

(i) Only Ca, Sr and Ba gives blue solution of ammoniated electron.

(ii) Be and Mg are small in size and have high ionisation potential so do not dissolves in liquid $NH_3$.

(iii) Dark blue colour of solution becomes fade if it allowed to stand for a long time, it is because of metal amide formation.

(iv) Blue colour of solution disappears on addition of ammonium salt, due to $NH_3$ formation.

$$NH_4^+ \quad + \quad NH_2^- \rightarrow \quad 2NH_3$$

## 8. PHOTO ELECTRIC EFFECT

These elements do not show this property as their atomic size is small hence ionisation potential is higher than IA group.

## 9. STANDARD OXIDATION POTENTIAL

(a) They have lower values of standard oxidation potential due to their small size.

(b) Increasing order of standard oxidation potential is -

$$\xrightarrow{\text{Be} < \text{Mg} < \text{Ca} < \text{Sr} < \text{Ba}}$$

(c) Tendendy of loosing electron increases

## 10. HYDRATION ENERGY (HEAT OF HYDRATION)

(a) Due to smaller ionic size and higher charge density their hydration energy is high.

(b) Its decreasing order is

$Be^{+2} > Mg^{+2} > Ca^{+2} > Sr^{+2} > Ba^{+2}$

(c) **Hydration energy $\propto$ 1/cation size**

## 11. REDUCING PROPERTY

(a) Less reductant than alkali metals

(b) Order of reducing property in aqueous and gaseous medium is

$Be^{+2} < Mg^{+2} < Ca^{+2} < Sr^{+2} < Ba^{+2}$

## 12. REACTION WITH AIR

(a) Except Be, these metals are easily turnished in air, as a Layer of oxide is formed on the surface.

(b) Barium in powdered form, burst into flame on exposure to air.

(c) In moist air, except Be all the elements converts into carbonates.

(d) In dry air Be and Mg gives nitride and oxide both while other gives only oxides.

## 13. REACTION WITH OXYGEN

(a) Alkaline earth metals reacts with $O_2$ to form 'MO' type oxides
(M = Be, Mg, Ca, Sr, Ba)

(b) But Ca, Sr and Ba due to low ionisation potential and more reactivity, forms $MO_2$ (peroxides) at low temperature.
**Ex.** $CaO_2$, $SrO_2$, $BaO_2$

(c) Peroxides are coloured due to Lattice deffect.

(d) BeO shows amphoteric property.

MgO → weak base

CaO, SrO & BaO → Strong base

(e) Basic properties increases from Be to Ba

(f) Its stability order general oxide > peroxide > super oxide

## 14. REACTION WITH WATER

(a) These metals reacts slowly with water gives $H_2$ and metals hydroxides.

$$M + 2H_2O \rightarrow M(OH)_2 + H_2$$

(b) Be does not reacts with water

(c) Mg reacts only with hot water

(d) Ca, Sr, Ba reacts with cold water but not as energetically as alkali metals. order of reactivity

Ba > Sr > Ca > Mg > Be

(e) from $Be(OH)_2$ to $Ba(OH)_2$ basic property and stability increases.

## 15. HALIDES

(a) Alkaline metals reacts with X (Halogen) to form $MX_2$.

**Ex.** ($BeCl_2$, $MgCl_2$, $CaCl_2$ etc.)

(b) Ionic nature of $MX_2$ increases from $BeCl_2$ to $BaCl_2$

(c) Ba burns in contact with $Cl_2$

(d) Hydrolytic nature of these halides decreases from $BeCl_2$ to $BaCl_2$

(e) $BeCl_2$ and $MgCl_2$ are covalent in nature. Order of ionic nature –

$BeCl_2 < MgCl_2 < CaCl_2 < SrCl_2 < BaCl_2$

Solubility in water

$BeCl_2 > MgCl_2 > CaCl_2 > SrCl_2 > BaCl_2$

## 16. CARBONATES

(a) All the alkaline metals forms $MCO_3$ type carbonates.

(b) Except $BeCO_3$, all the carbonates are stable towards heat

$$BeCO_3 \xrightarrow{\Delta} BeO + CO_2$$

(c) Order of decreasing stability -

$BaCO_3 > SrCO_3 > CaCO_3 > MgCO_3 > BeCO_3$

## 17. NITRATES

(a) Alkaline earth metals forms $M(NO_3)_2$ type nitrates. (M –Alkaline earth metal).

(b) Stability increases from $Be(NO_3)_2$ to $Ba(NO_3)_2$ but these are less stable than IA group, due to smaller atomic size.

(c) All alkaline metals nitrates on heating gives oxides and $NO_2 + O_2$

$$M(NO_3)_2 \xrightarrow{\Delta} Oxides + NO_2 + O_2$$

(d) $Be(NO_3)_2$ forms a layer of BeO on its surface so reaction stops.

## 18. NITRIDES

Only Be and Mg burns in $N_2$ to give $M_3N_2$ ($Be_3N_2$, $Mg_3N_2$)

$$Be_3N_2 + 6H_2O \rightarrow 3Be(OH)_2 + 2NH_3$$

$$Mg_3N_2 + 6H_2O \rightarrow 3Mg(OH)_2 + 2NH_3$$

## 19. FORMATION OF AMALGAM

Shows same properties as alkali matals.

## 20. SULPHATES

(a) Alkaline earth metals forms $MSO_4$ type sulphates.

(b) Ionic nature of alkaline metal sulphat is increases from Be to Ba

$BeSO_4 < MgSO_4 < CaSO_4 < SrSO_4 < BaSO_4$

(c) Solubility decreases from $BeSO_4$ to $BaSO_4$ as $Be^{+2}$ and $Mg^{+2}$ are of small size so their hydration energy is high Hydration Energy > Lattice energy.

(d) Order of solubility –

$BeSO_4 > MgSO_4 > CaSO_4 > SrSO_4 > BaSO_4$

(e) Order of thermal stability –

$BeSO_4$, $MgSO_4$, $CaSO_4$, $SrSO_4$, $BaSO_4$

$$\xrightarrow{\hspace{8cm}}$$

Ionic nature increases, Thermal stability increases

## 21. REACTION WITH ACIDS

Freely reacts with acids and displaces hydrogen

$$M + 2HCl \rightarrow MCl_2 + H_2\uparrow$$

# COMPOUNDS OF ALKALINE EARTH METALS

## 1. MAGNESIUM

(a) **Preparation :**

(i) **From Magnesite or Dolomite** : The ore is first calcined to form the oxide

$MgCO_3 \longrightarrow MgO + CO_2$ and $CaCO_3.MgCO_3 \longrightarrow CaO. MgO + 2CO_2$

(ii) **From MgO** : The oxide is mixed with carbon and heated in a current of chlorine gas

$MgO + C + Cl_2 \longrightarrow MgCl_2 + CO$

The chloride thus obtained is subjected to electrolysis.

(iii) The mixed oxides (CaO.MgO) obtained from calcination of dolomite ($CaCO_3$ $MgCO_3$) are reduced by ferrosilicon under reduced pressure above 1273 K.

(iv) It is prepared by the electrolysis of fused magnesium chloride.

(b) **Properties**

(i) Magnesium burns in air with dazzling light.

$$2Mg + O_2 \longrightarrow 2MgO$$

(ii) Burning Mg continues to burn in $CO_2$ forming MgO because reducing nature Mg > C

$$2Mg + CO_2 \longrightarrow 2MgO + C$$

(c) **Uses**

(i) In preparation of alloy
Electron : 95% Mg + 5% Zn, air craft
Magnalium : 1 – 15% Mg + 85 – 99% Al, used in aeroplanes, balance beams, light instruments.

(ii) In photographic flash light.

(iii) In preparation of Grignard's reagent.

## 2. MAGNESIUM CHLORIDE $MgCl_2$

(a) **Occurrence** : It is mainly found in sea water and carnallite $KCl.MgCl_2.6H_2O$.

(b) **Preparation** :

(i) By reaction of dil HCl on $MgCO_3$

$$MgCO_3 + 2HCl \longrightarrow MgCl_2 + CO_2 + H_2O$$

(ii) $MgCl_2$ is obtained by burning Mg metal in chlorine

$$Mg + Cl_2 \xrightarrow{\text{Heated}} MgCl_2$$

(c) **Properties**

On heating $MgCl_2.6H_2O$, it gets hydrolysed by its own water of crystallization to an oxy chlorides.

$$MgCl_2.6H_2O \xrightarrow{\Delta} MgO + 2HCl + 5H_2O$$

(d) **Uses**

(i) For preparation of metallic magnesium.

(ii) In manufacture of magnesia cement.

(iii) Used for dressing cotton threads.

## 3. MAGNESIUM SULPHATE $MgSO_4$

(a) **Occurrence** : It occurs naturally as kiserite ($MgSO_4.H_2O$) and epsomite ($MgSO_4.7H_2O$).

(b) **Preparation**

By dissolving magnesite in dil. $H_2SO_4$

$$MgCO_3 + H_2SO_4 \longrightarrow MgSO_4 + H_2O + CO_2\uparrow$$

(c) **Properties** :On heating above $200^0C$

$$2MgSO_4 \xrightarrow[\text{200 C}]{\text{Above}} 2MgO + 2SO_2 + O_2$$

**Note** : It is used in medicine as purgative.

## 4. CALCIUM

(a) **Extraction**

(i) It is obtained by the electrolysis of fused $CaCl_2$. By adding $CaF_2$ melting point of $CaCl_2$ ($780^0C$) decreased.

$$CaCl_2 \overset{\text{700 C}}{\rightleftharpoons} Ca^{++} + 2Cl^-$$

At Cathode (Iron) $Ca^{++} + 2e^- \longrightarrow Ca$ and at Anode(Graphite) $2Cl^- \longrightarrow Cl_2 + 2e^-$

(ii) **Goldschmidt (thermite) Process**

$$3CaO + 2Al \longrightarrow Al_2O_3 + 3Ca$$

CaO is reduced by Al because it has greater affinity for oxygen than Ca.

(b) **Properties**

(i) **With air**

$$2Ca + O_2 \xrightarrow{\text{Burning}} 2CaO \quad \text{and} \quad 3Ca + N_2 \xrightarrow{\text{Burning}} Ca_3N_2$$

(ii)

$$Ca \xrightarrow{H_2,\,\Delta} CaH_2 \text{ (Hydrolith)}$$

$$Ca \xrightarrow{\text{Cold } H_2O} Ca(OH)_2 + H_2$$

(c) **Uses**

(i) For removal of sulphur from petroleum

(ii) As a dehydrating agent in preparation of absolute alcohol

(iii) It is used as a deoxidiser for copper, cast Iron and steel

## 5. CALCIUM OXIDE (CaO) QUICK LIME

(a) **Preparation :** By heating limestones at $800^0$C.

$$CaCO_3 \xrightleftharpoons{800\ C} CaO + CO_2$$

(b) **Properties**

(i) **Action of water :** $CaO + H_2O \longrightarrow Ca(OH)_2$

(quick lime) (Slaked lime)

$Ca(OH)_2$ paste in water called milk of lime.

(ii) **Basic Nature :**

$$\underset{}{CaO + SiO_2 \xrightarrow{\Delta} \underset{\text{(Calcium silicate)}}{CaSiO_3}} \quad \text{and} \quad CaO + P_4O_{10} \xrightarrow{\Delta} 2Ca_3(PO_4)_2$$

(iii) Reaction with carbon : $CaO + 3C \xrightarrow{2000\ C} CaC_2 + CO\uparrow$

(c) **Uses**

(i) In the manufacture of bleaching powder, cement, glass, calcium carbide etc.

(ii) In the purification of sugar

(iii) As a drying agent for $NH_3$ and $C_2H_5OH$

(iv) As basic lining in furnaces

(v) For making Soda lime

## 6. CALCIUM HYDROXIDE $Ca(OH)_2$ SLAKED LIME

(a) **Preparation :** By the action of water on quick lime

$$CaO + H_2O \longrightarrow Ca(OH)_2 + \text{heat}$$

(b) **Properties**

(i) **Action of $CO_2$** : Lime water turns milky on passing $CO_2$ gas.

$$Ca(OH)_2 + CO_2 \longrightarrow \underset{\text{Milkiness}}{CaCO_3} + H_2O$$

$$CaCO_3 \xrightarrow[CO_2]{\text{Excess of}} Ca(HCO_3)_2 \text{ (soluble)}$$

(ii) **Action of Chlorine :**

$$Ca(OH)_2 + \underset{\text{dry}}{Cl_2} \xrightarrow{\text{below } 35\ C} \underset{\text{Bleaching powder}}{CaOCl_2} + H_2O$$

$$2Ca(OH)_2 + 2Cl_2 \xrightarrow{\text{red heat}} 2CaCl_2 + 2H_2O + O_2\uparrow$$

(c) **Uses**

(i) For softening of hard water.

(ii) For purification of sugar and Coal gas.

(iii) In the manufacture of bleaching powder, Caustic soda and soda lime

(iv) In preparation of mortar, plaster and white washing.

## 7. CALCIUM CARBONATE ($CaCO_3$)

(a) It ocurs in nature as marble, limestone, chalk, coral, calcite etc. It is prepared by dissolving marble or limestone in HCl and removing iron and aluminium present, by precipitating with $NH_3$ and then adding $(NH_4)_2CO_3$ to the solution.

$$CaCl_2 + (NH_4)_2CO_3 \longrightarrow CaCO_3 + 2NH_4Cl$$

(b) **Properties**

(i) It dissociates above 1000°C as follows: $CaCO_3 \longrightarrow CaO + CO_2$

(ii) It dissolves in water containing $CO_2$ forming $Ca(HCO_3)_2$ but is precipitated from the solution by boiling

$$CaCO_3 + H_2O + CO_2 \underset{\text{boiling}}{\rightleftharpoons} Ca(HCO_3)_2$$

(c) **Uses**

(i) In the preparation tooth pastes, cosmetics face powder and medicine for indigestion.

(ii) In the preparation of Quick lime.

(iii) As a building material.

(iv) In manufacture of cement, glass, washing soad etc.

## 8. CACLIUM SULPHATE $CaSO_4.2H_2O$ (GYPSUM)

(a) **Preparation :** $CaSO_4.2H_2O$ is naturally occuring calcium sulphate. It can be obtained by the action of dil.$H_2SO_4$ on a soluble calcium salt below $60^0$C.

$$CaCl_2 + \underset{\text{dilute}}{H_2SO_4} \longrightarrow 2HCl + \underset{\text{white ppt.}}{CaSO_4\downarrow}$$

(b) **Properties**

(i) **Action of heat**

$$2CaSO_4.2H_2O \xrightarrow[-3H_2O]{120\ C} \underset{\text{(Plaster of paris)}}{(CaSO_4)_2.H_2O} \xrightarrow{200\ C} \underset{\text{(Anhydride)}}{2CaSO_4} + H_2O$$

(ii) It forms an important fertilizer $(NH_4)_2SO_4$

$$CaSO_4 + 2NH_3 + CO_2 + H_2O \longrightarrow CaCO_3\downarrow + (NH_4)_2SO_4$$

(c) **Uses**

(i) In the preparation of plaster of paris

(ii) Anhydrous $CaSO_4$ used as drying agent.

(iii) Anhydride ($CaSO_4$) is used for manufacture of sulphuric acid, ammonium sulphate.

## 9. PLASTER OF PARIS ($2CaSO_4.H_2O$ )

(a) **Preparation :** It obtained when gypsum is heated at $120^0C$

$$2(CaSO_4.2H_2O) \xrightarrow{\quad\quad} 2CaSO_4.H_2O \quad + \quad 3H_2O$$

(b) **Properties**

(i) It is a white powder.

(ii) It has the property of setting to a hard mass when a paste with water is allowed to stand aside for sometime.

(iii) When it heated at $200^0C$, anhydrous $CaSO_4$ is formed.

(c) **Uses**

(i) In surgery for setting broken bones

(ii) In making casts for toys, statues etc.

(iii) In making blackboard chalks.

## 10. SIMILARITIES BETWEEN LITHIUM AND MAGNESIUM

(a) Both lithium and magnesium are harder and lighter than other elements in the respective groups.

(b) Lithium and magnesium react slowly with cold water. Their oxides and hydroxides are much less soluble and their hydroxides decompose on heating. Both form a nitride by direct combination with nitrogen, $Li_3N$ and $Mg_3N_2$.

(c) The oxides, $Li_2O$ and MgO do not combine with excess oxygen to give a peroxide or a superoxide.

(d) The carbonates of lithium and magnesium decompose easily on heating to form the oxide and $CO_2$. Solid bicarbonates are not formed by lithium and magnesium.

(e) Both LiCl and $MgCl_2$ are soluble in ethanol.

(f) Both LiCl and $MgCl_2$ are deliquescent and crystallise from aqueous solution as hydrates,

$LiCl.2H_2O$ and $MgCl_2.8H_2O$.

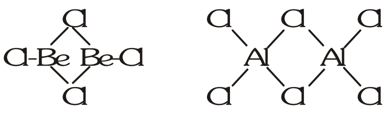
## 11. DIAGONAL SIMILARITY BETWEEN BERYLLIUM AND ALUMINIUM :

In many of its properties, beryllium resembles aluminium. Thus –

(a) The two elements have same electronegativity and their charge/ radius ratios.

(b) Both metals are fairly resistant to the action of acids due to a protective film of oxide on the surface. Both metals are acted upon by strong alkalies to form soluble complexes, beryllates $[Be(OH)_4]^{2-}$ and aluminates, $[Al(OH)_4]^-$ .

(c) The chlorides of both beryllium and aluminium



have bridged chloride structures in vapour phase.

(d) Salts of these metals form hydrated ions, Ex. $[Be(OH_2)_4]^{2+}$ and $[Al(OH_2)_6]^{3+}$ in aqueous solutions. Due to similar charge/ radius ratios of beryllium and aluminium ions have strong tendency to form complexes. For example beryllium forms tetrahedral complexes such as $BeF_4^{\ 2-}$ and $[Be(C_2O_4)_2]^{2-}$ and aluminium forms octahedral complexes like $AlF_6^{\ 3-}$ and $[Al(C_2O_4)_3]^{3-}$.

# IMPORTANT COMPOUNDS AND THEIR FORMULA

1. Active nitrogen : N(atomic nitrogen)
2. Alums : $M_2'SO_4 \,.\, M_2'''(SO_4)_3 \,.\, 24H_2O$
   $M' = K^+, NH_4^+, Na^+$ etc.
   $M''' = Cr^{+3}, Al^{+3}, Fe^{+3}$ etc.
3. Asbestos : $CaMg_3(SiO_3)_4$
4. Arsine : $AsH_3$
5. Aquaregia : Conc. $HNO_3$ + Conc. HCl (1 : 3 part)
6. Anhydrone : $Mg(ClO_4)_2$
7. Argentoferrous galena : $PbS + Ag_2S$
8. Borax : $Na_2B_4O_7 \,.\, 10H_2O$
9. Blue vitriol : $CuSO_4, 5H_2O$
10. Barytes : $BaSO_4$
11. Baryta water : $Ba(OH)_2$ solution
12. Baryta : BaO
13. Baking soda : $NaHCO_3$
14. Bleaching powder : $CaOCl_2$
15. Boranes : Hydride of borone
16. Brine : NaCl solution
17. Calgon : $Na_2[Na_4(PO_3)_6]$
18. Coinage metals : Cu, Ag and Au
19. Carborundum : SiC
20. Cementite : FeC
21. Caliche : $NaNO_3 + NaIO_3$
22. Caustic soda : NaOH
23. Caustic potash : KOH
24. Calomel : $Hg_2Cl_2$
25. Corrosive sublimate : $HgCl_2$
26. Deuterium : ${}_1H^2$ of D
27. D.D.T. : p-dichloro, diphenyl, trichloroethane
28. Dry ice : Solid $CO_2$
29. Freon : $CF_2Cl_2$
30. Ferric Alum : $K_2SO_4 \,.\, Fe_2(SO_4)_3 \,.\, 24H_2O$

31. Fenton's reagent : $H_2O_2$ + few drops of $FeSO_4$
32. Fusion mixutre : $Na_2CO_3 + K_2CO_3$
33. Fluid magnesia : 12% solution of $Mg (HCO)_2$
34. Fehling solution : $CuSO_4 . 5H_2O$ + NaOH + Na, K tartarate
35. King of metals : Gold
36. Horn Silver : AgCl
37. Green vitriol : $FeSO_4 . 7H_2O$
38. Graphite : An allotrope of carbon
39. Gun powder : 75% $KNO_3$ + 12%S + 13% charcoal (explosive)
40. Glauber salt : $Na_2SO_4 . 10H_2O$
41. Hydrolith : $CaH_2$
42. Heavy water : $D_2O$
43. Hypo (sodium thiosulphate) : $Na_2S_2O_3 . 5H_2O$
44. Heavy hydrogen : $D_2$
45. King of chemicals : $H_2SO_4$
46. Lime (quick lime or burnt lime) : CaO
47. Lead pencil : Graphite
48. Lime water : $Ca(OH)_2$
49. Laughing gas : $N_2O$
50. Lunar Caustic : $AgNO_3$
51. Litharge (Masscote) : PbO
52. Lithopone : ($ZnS + BaSO_4$), a pigment
53. Mortar : Slaked lime + sand (1 : 3 in water)
54. Mica : $K_2O. Al_2O_3 . 6SiO_2 . 2H_2O$
55. Mohr salt : $FeSO_4 . (NH_4)_2SO_4 . 6H_2O$
56. Matte : $Cu_2S + FeS$
57. Milk of lime : $Ca(OH)_2$ in water

58. Minium : $Pb_3O_4$
59. Micro cosmic salt : $NaNH_4 . HPO_4 . 4H_2O$(used in test of silicates)
60. Milk of magnesia : Paste of $Mg(OH)_2$ in water (Antacid)
61. Magnesia : $MgO$
62. Marsh gas : $CH_4$
63. Nitrolim : $CaCN_2 + C$ (a fertilizer)
64. Nascent Hydrogen : H at the moment of generation
65. Nessler's reagent : $(K_2HgI_4 + KOH)$ aqueous solution
66. Indian saltpetre, Bengal salt petre : $KNO_3$
67. Oil of vitriol : Conc. $H_2SO_4$
68. Ozone : $O_3$
69. Oleum : $H_2S_2O_7$
70. Permutit (Zeolite) : $Na_2Al_2SiO_8 . XH_2O$
71. Pearl ash (Potash) : $K_2CO_3$
72. Plaster of paris : $CaSO_4 \frac{1}{2} H_2O$ or $2CaSO_4 . H_2O$
73. Philospher's wool (chinese white) : ZnO (Zinc white)
74. Phosgene : $COCl_2$
75. Phosphine : $PH_3$
76. Pig iron : Impure form of iron
77. Producer gas : A mixture of $CO + N_2 + H_2$
78. Quartz : $SiO_2$
79. Refrigerant : $CO_2$, $NH_3 . CF_2Cl_2$ etc.
80. Red lead : $Pb_3O_4$
81. Rochelle salt : Sodium - potassium tartarate
82. Rust : $Fe_2O_3 . xH_2O$
83. Sorel's cement (Magnesia cement) : $MgCl_2 . 5MgO . XH_2O$
84. Soda - lime : $NaOH + CaO$
85. Soda ash : $Na_2CO_3$ (anhydrous)
86. Slaked lime : $Ca(OH)_2$
87. Stainless steel : An alloy of Fe, Cr and C
88. Salt cake : $Na_2SO_4$ (anhydrous)
89. Super phosphate : $Ca(H_2PO_4) + 2CaSO_4$

90. TNT : Trinitro toluene (an explosive)

91. TNB : Trinitro benzene (an explosive)

92. Tincal : $Na_2B_4O_7 . 10H_2O$

93. Talc : $3MgO . 4SiO_2 . H_2O$ or $Mg_2 (Si_2O_3)_2 . Mg(OH)_2$

94. Tritium : ${}_1H^3$(an isotope of H)

95. Water glass : $Na_2SiO_3$

96. Water gas : $CO + H_2$

97. White vitriol : $ZnSO_4 . 7H_2O$

98. Wrought iron : Pure form of iron

99. Washing soda : $Na_2CO_3 . 10H_2O$

100. Willemite \ Zincite : ZnO

101. Zinc white : ZnO

102. Zinc blend : ZnS

## INDUSTRIALLY IMPORTANT PROCESS

Ammonia Soda process (Solvay process) : Manufacture of $NaHCO_3$, $Na_2 CO_3$

Birkeland - Eyde process : Manufacture of $HNO_3$

Bosch process : Manufacture of $H_2$

Castner process : Manufacture of Na

Caster - Kellner Cell process : Manufacture of NaOH

Contact process : Manufacture of $H_2SO_4$

Down process : Manufacture of Na

Dow's process : Manufacture of phenol

Deacon's process : Manufacture of $Cl_2$

Haber process : Manufacture of $NH_3$

Hasenclever process : Manufacture of Bleaching powder

L.D. process : Manufacture of steel

Lead chamber process : Manufacture of $H_2SO_4$

Nelson cell process : Manufacture of NaOH

Ostwald process : Manufacture of $HNO_3$