

# S-Block Elements

classmate

Date \_\_\_\_\_

Page \_\_\_\_\_

## S-Block Elements

I A / Alkali metal

group

II A / Alkaline Earth metal

Most electropositive Metal group

s  
block  
Elements

$nS^{1-2}$

$nS^1$  - I A

$nS^2$  - II A

Soft Metal (due to weak metallic bond)

IA  $\rightarrow$  +1  $\rightarrow$  Univalent Ionic

Small cohesive Energy

II A  $\rightarrow$  +2  $\rightarrow$  Bivalent Ionic compound

(crystals  $\rightarrow$  Enthalpy of atomisation ( $\Delta E > 1.9$ ))

$\Delta aH$

$\rightarrow$  very low

$\therefore \downarrow MP \downarrow ES$

	MP	CE
Li	181°C	161
Na	98°C	108
K	63°C	90
Rb	39°C	82
Cs	28.5°C	78
Fm	Liq. at Room Temp.	

Radioactive  
Half life  $\rightarrow$  28 days

- Least complicated group of Periodic table

↓

Because no such exceptional size difference seen down the group. i.e. atomic size ↑  
Ionic radii ↑

- All the elements are metals.

↓

Good conductors of electricity.

Form Ionic compounds

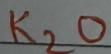
Oxosalts are either white / colourless  
Oxides and hydrides are highly basic in nature.

Soluble in water. That's why they are called Alkali.

### "Alkali Metal Group"

- General formula is  $ns^1$ .

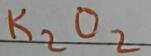
Univalent  $\rightarrow +1$



+1

$\text{O}^{2-}$

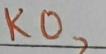
"Oxide"



+1

$\text{O}_2^{2-}$

"Peroxide"



+1

$\text{O}_2^-$

"Superoxide"

- Li Exceptional behaviour

Na } 4% of Earth's crust

K

Rb

Cs

F<sub>2</sub>

1

0.9

0.9

0.8

0.7

} EN

• Exceptionally low density  
Even Li, Na, K can float on water.

Li	0.54
Na	0.97
K	0.84
Rb	1.53
Cs	1.60

**K****Rb****Cs**

0.54

0.97

0.84

1.53

1.60

{ }

Densities of Alkali Metal

due to more increase in volume than mass. (Introduction of d orbitals).

Density order  $\rightarrow$  Li < K < Na < Rb < Cs $M^{n+}$  $(IE_1) n=1 >>> n=2 (IE_2)$ 

to get noble gas configuration

very difficult to take out e<sup>-</sup> from full filled valence shell $IE_1 <<< IE_2$ 

• All the alkali metals are miscible in each other except lithium.



due to small size.

	At. radii (M)	Ionic radii (M <sup>+</sup> ) ← (in pm)
Li	152	76
Na	186	102
K	227	138
Rb	248	154
Cs	265	167

Lithium compounds are most covalent or least Ionic.

Acc. to Fajan's Rule

Small cation & Polarising Power  
& Covalent character.

### Born - Haber Cycle

$$\Delta G = \Delta H - T \Delta S$$

$\Delta G$  → Gibb's Free Energy

$\Delta H$  → Enthalpy of Formation

T → Temperature

$\Delta S$  → Entropy change

$\Delta S$  → Entropy change → Randomness

Gas > Liqu. > Solid > Cryst.  
Solid

If state changes then only  
 $T \Delta S$  significant

$$\therefore \Delta G = \Delta H$$

$\Delta G$ -ve  $\rightarrow$  Feasible+ve  $\rightarrow$  Non-feasible

Born-Haber cycle explains:

Lattice Energy

Solubility

Hydration Energy

Stability of Crystalline Ionic solid

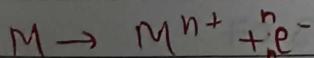
 $\Delta f H$  Enthalpy of formation.

## Redox Reaction

Redox Reaction

+ O<sub>2</sub> / H<sub>2</sub> Exchange+ e<sup>-</sup> exchangee<sup>-</sup> donorM / M<sup>+</sup>

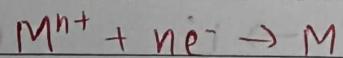
Oxidation



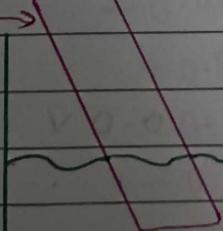
For Alkali Metal n = 1

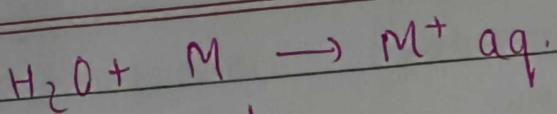
e<sup>-</sup> gainerM / M<sup>-</sup>

Reduction



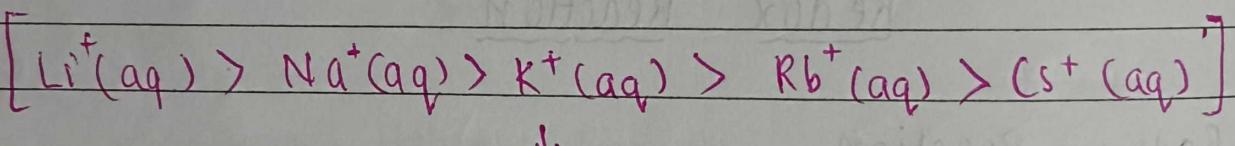
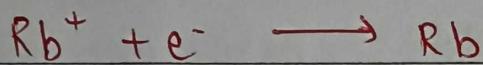
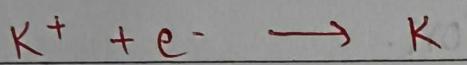
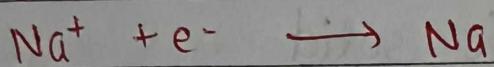
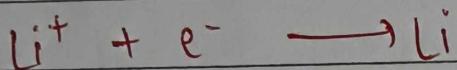
Metal rod

 $\rightarrow H_2O$



It is formed more quickly by the metal whose tendency to donate  $e^-$  is high.  
OR

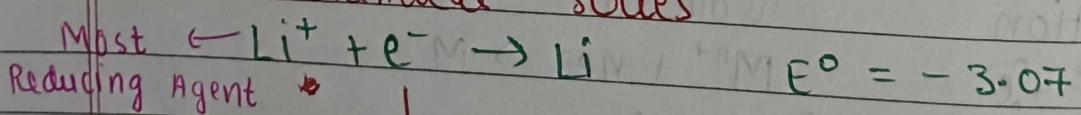
Metal whose reduction is difficult.



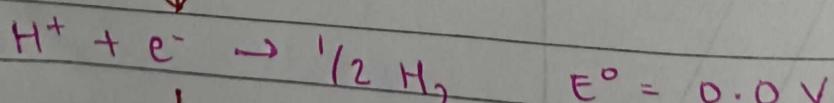
### Enthalpy of Hydration

Arrangement of elements in increasing order of Electrode potential (reduction) is called Electrochemical series (ECE)

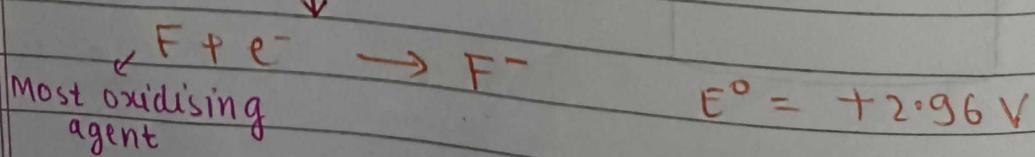
#### • Electrochemical series



(-ve) values



(+ve values)

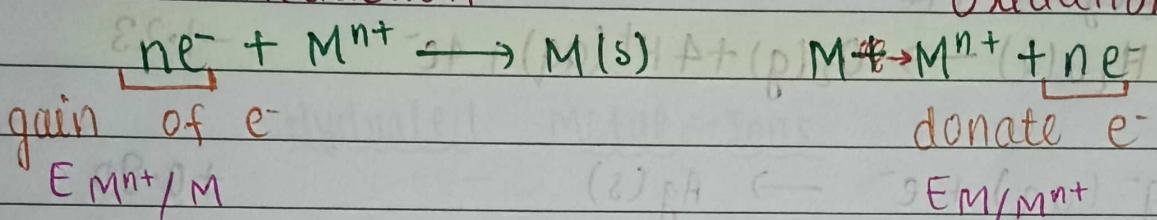


## Electrode Potential (E)

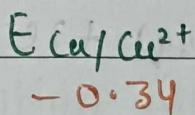
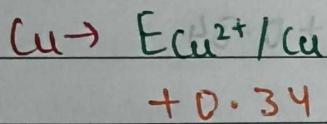
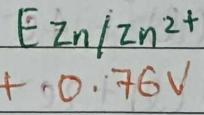
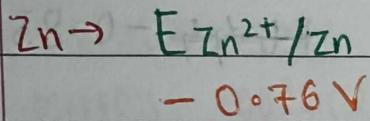
Amount of work done which can be done by an electrode towards exchange of electrons.

### Redox

#### Reduction



#### Oxidation



More oxidation - Zn

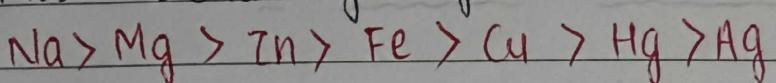
More reduction - Cu

	$M^{n+}/M$
Mg	-2.4 V
Na	-2.85 V
Fe	-0.44 V
Ag	+0.8 V
Cu	+0.34 V
Hg	+0.79 V
Zn	-0.76 V

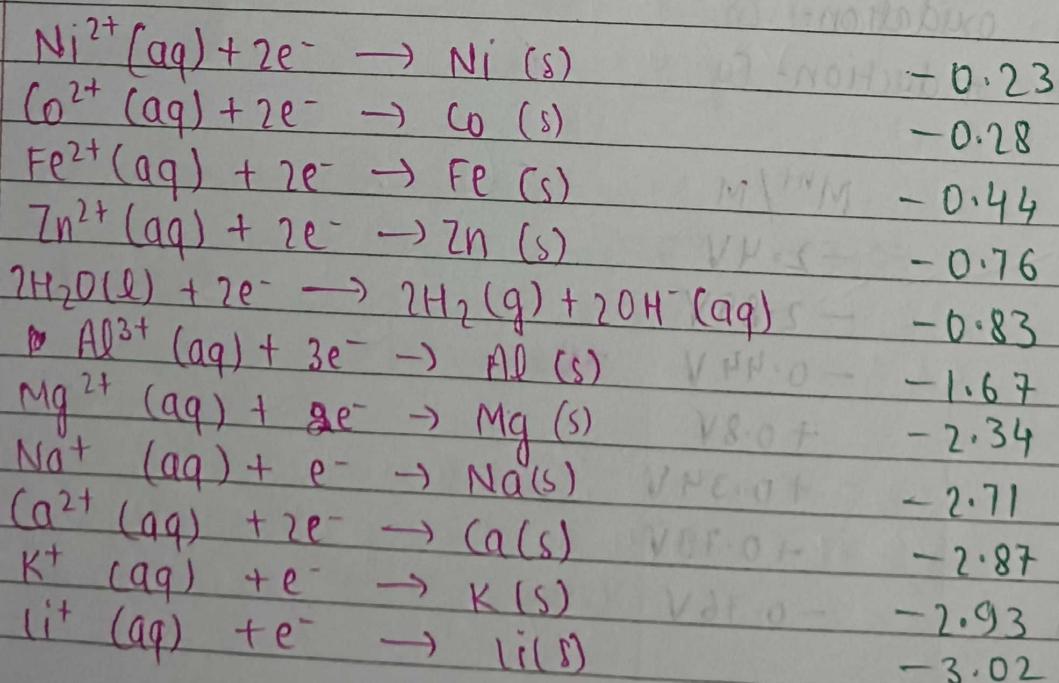
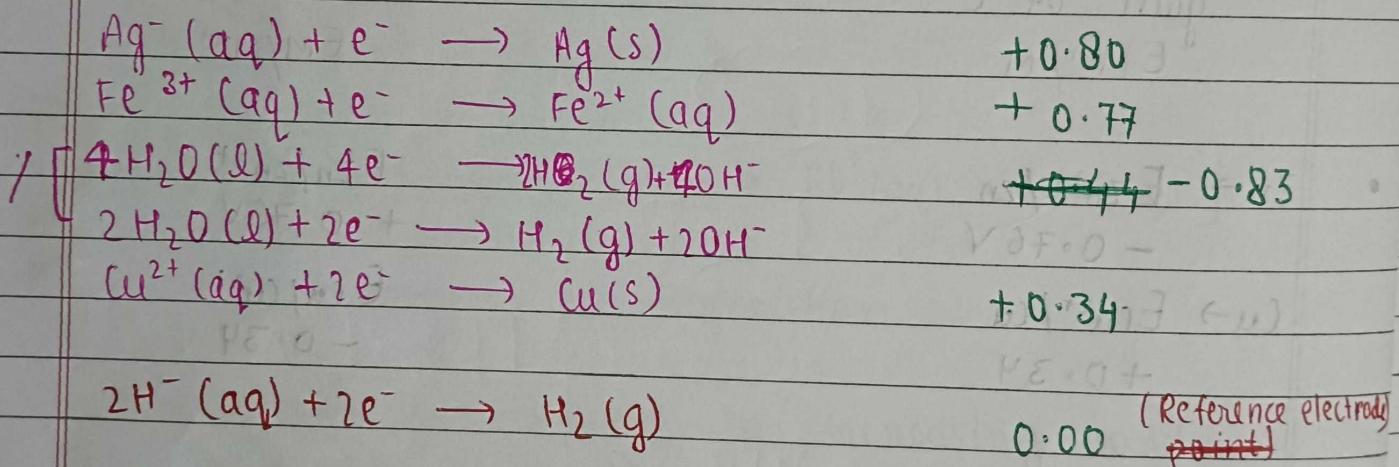
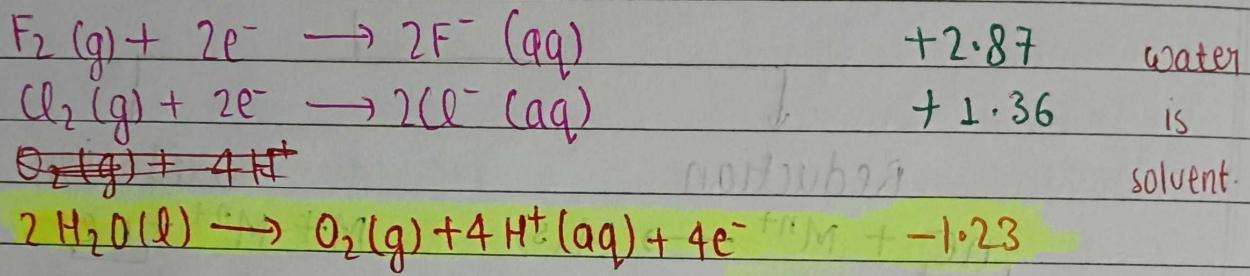
→ Most oxidising agent order :-

$Ag > Hg > Cu > Fe > Zn > Mg > Na$

→ Most reducing agent order :-



## E Electrochemical Series



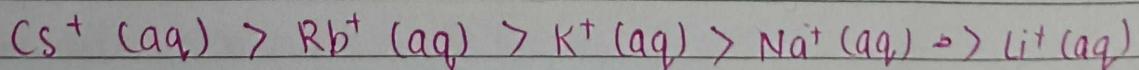
- Water is solvent for all metals.
- $2H^-(aq) + 2e^- \rightarrow H_2(g)$  is the reference electrode.  
All the values are w.r.t. this electrode.
- Among all metals in aqueous medium, most ionizing is Lithium. That's why its hydration energy is exceptionally high.

### Hydrated Metal Ions.

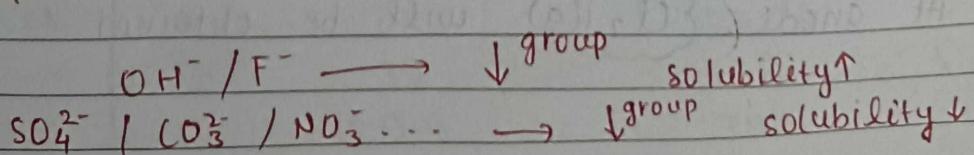
Due to concentrated +ve charge alkali metals can surround by large number of water molecules.

Down the group, extent of hydration decreases.  
The lithium ion ( $Li^+(aq)$ ) is most hydrated form surrounded by large number of water molecules in primary and secondary arrangement.

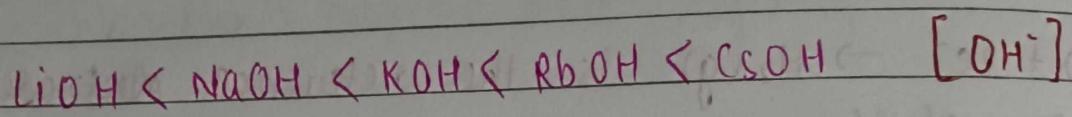
- Order of Ionic Mobility ( $\mu$ )  $\rightarrow$  Speed of ions in aqueous medium



- No alkali metal compound can form ppt. in water. All are soluble in water.



~~Solubility~~ Solubility Order:-



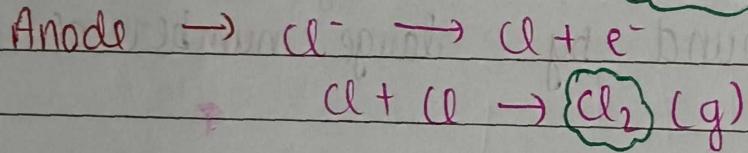
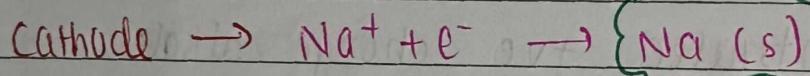
Anode always performs oxidation.  
Cathode always performs reduction.



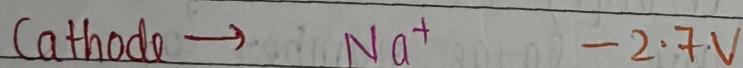
## Electrolyte



I.  $\text{NaCl}$  molten - Down's Process

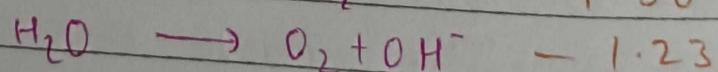
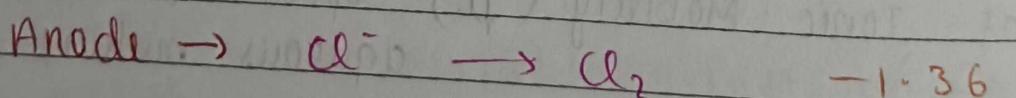


II.  $\text{NaCl}$  aqueous - Chloralkali Process



So,

At cathode,  $\text{H}_2 \text{ (g)}$  will be obtained.

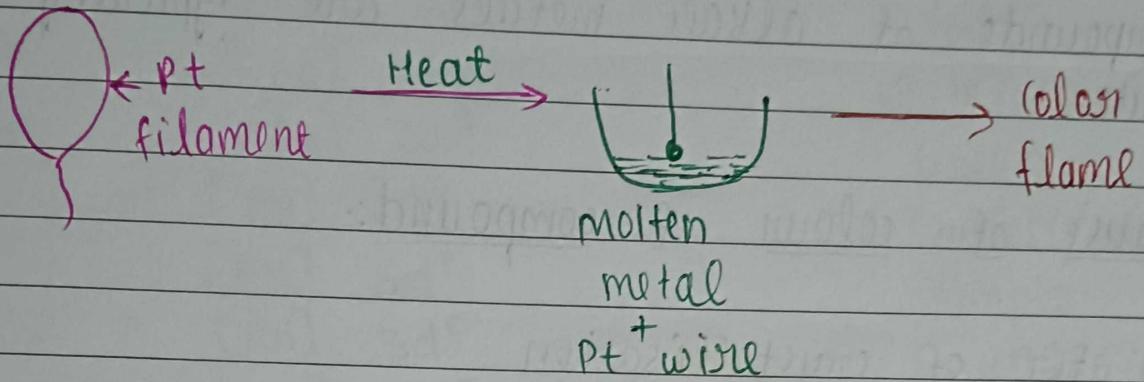


$E^\circ$  of  $\text{H}_2\text{O} > \text{Cl}_2$  but due to H-bonding  $E^\circ$  of  $\text{H}_2\text{O} = -1.48\text{V}$   
Hence,

At anode,  $\text{Cl}_2 \text{ (g)}$  will be obtained.

Flame test

Ca + Element  $\rightarrow$  crushed into powdered form.

Flame Colour

Li	Crimson Red	Be	—
Na	Golden Yellow	Mg	—
K	Violet	Ca	Brick Red
Rb	Reddish Violet	Sr	Caramine Red
Cs	Bluish Violet	Ba	Apple Green

Be and Mg don't give flame colour due to exceptionally high I.E.

Melting and Boiling Point

The exceptionally low Melting and Boiling Point of alkali metals is due to weak metallic bond.

		M.P. (°C)	B.P. (°C)
M.P. and B.P. ↓ es.	Li	181	1347
	Na	98	886
	K	63	766
	Rb	39	688 *Excep
	Cs	29.5	705
	Liquid at R.T.		

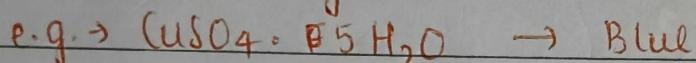
Hg, Cs, Ga  
and Os  
are liquid  
at Room  
Temp.

Lithium is hardest alkali metal due to its crystalline form.

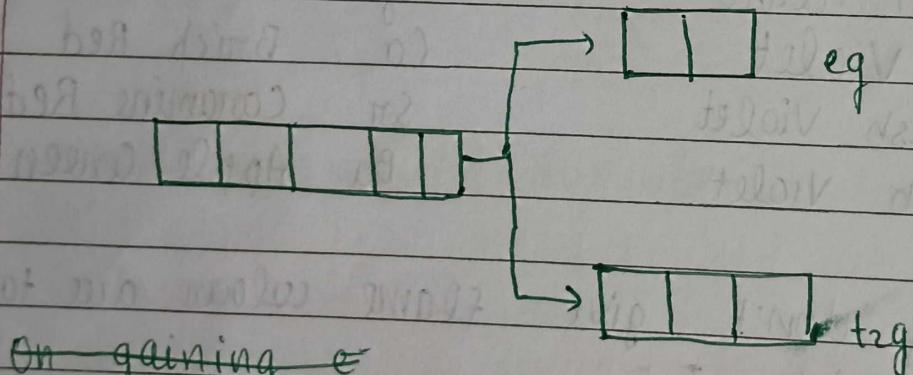
Compounds of alkali metals are typically white.

### Cause of colour of compound:-

1. Water of crystallisation



2. d-d transition of  $e^-$



On gaining  $e^-$

$e^-$  jump to higher orbits and comes back to t<sub>2g</sub> after releasing radiation.

3. Ionic character %

$$\mu = 16(X_A - X_B) + 3.5(X_A - X_B)^2$$

AgI Deep Yellow

AgBr Yellow

AgCl White

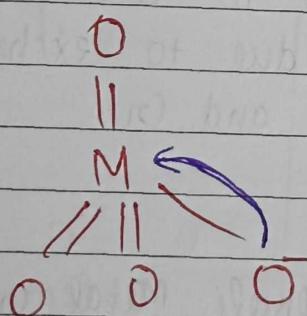
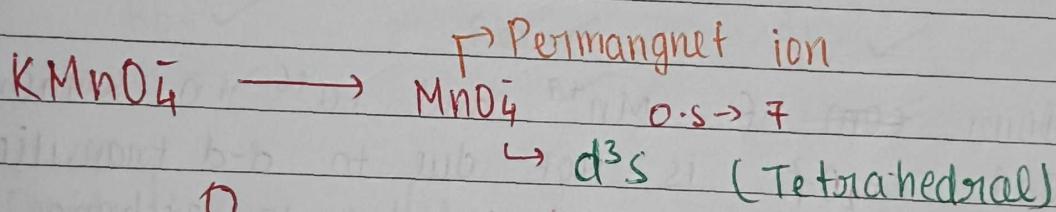
AgF Soluble

< 20% - ppt.

#### 4. Unpaired e<sup>-</sup> / e<sup>-</sup> exchange

	No. of
Fe <sup>2+</sup> → [Ar] 3d <sup>6</sup>	4
Fe <sup>3+</sup> → [Ar] 3d <sup>5</sup> 3d <sup>5</sup> Yellow	5
Zn <sup>2+</sup> → [Ar] 3d <sup>10</sup> 3d <sup>10</sup> white/colourless	0
Cu <sup>2+</sup> → [Ar] 3d <sup>9</sup>	1
Sc <sup>3+</sup> → [Ar] 3d <sup>0</sup> 3d <sup>0</sup> Green	0
Mn <sup>+7</sup> → [Ar] 3d <sup>3</sup> 3d <sup>0</sup> (colourless/white)	0
Cr <sup>+6</sup> → [Ar] 3d <sup>8</sup> Purple	0
Cr <sup>+3</sup> → [Ar] 3d <sup>3</sup> 3d <sup>3</sup> Orange	0
	Green
	3

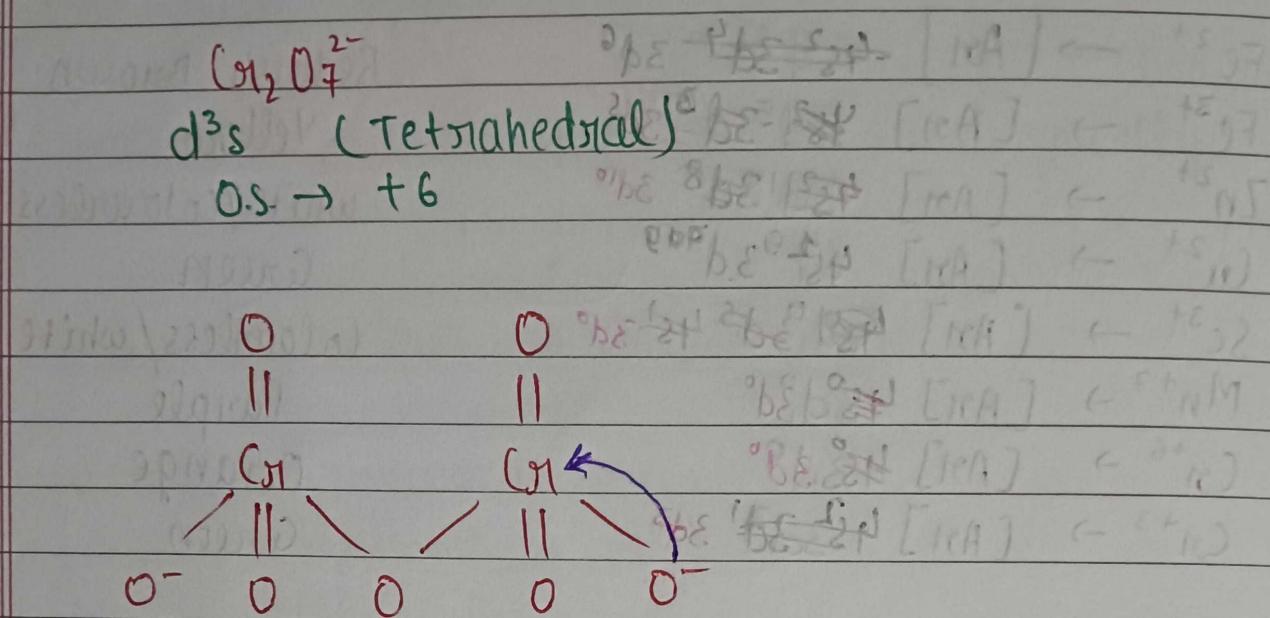
Case 1: KMnO<sub>4</sub>



Name two oxometal anion whose group number are same.

Ans: MnO<sub>4</sub><sup>-</sup> and Cr<sub>2</sub>O<sub>7</sub><sup>2-</sup>

## Case II :- Dichromate ion.

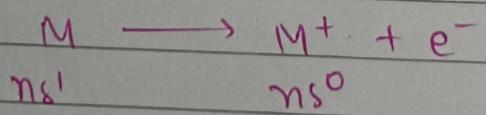


Colour ~~of~~ of  $\text{Mn}^{+7}$  and  $\text{Cu}^{+6}$  in  $\text{KMnO}_4$  and  $\text{Cr}_2\text{O}_7^{2-}$  is not due to d-d transition or unpaired  $e^-$ . It is due to exchange of  $e^-$  from oxygen of Mn and Cr.

### Magnetic Behaviour of Alkali Metal Compounds

1. Paramagnetic  $\rightarrow$  No. of unpaired  $e^-$
2. Diamagnetic  $\rightarrow$  Absence of unpaired  $e^-$

For alkali metals



3. Ferromagnetic  $\rightarrow$  Always show magnetic behaviour

## Oxides of Alkali metals :-

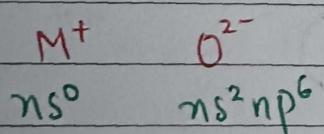
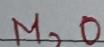
$M_2O \rightarrow$  Oxide

$M_2O_2 \rightarrow$  Peroxide

$MO_2 \rightarrow$  Superoxide

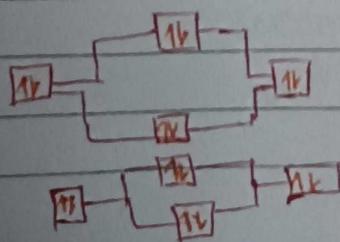
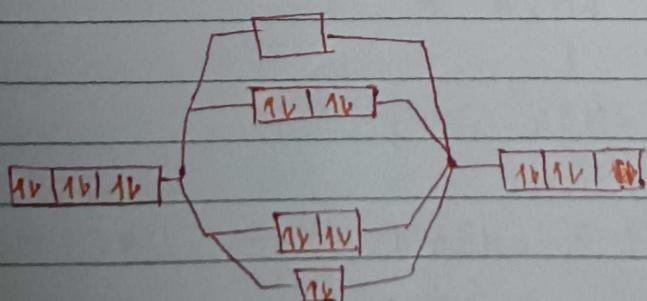
$M \xrightarrow{O_2}$	$M_2O$ $M^+ O^{2-}$ Oxide	$M_2O_2$ $M^+ O_2^{2-}$ Peroxide	$MO_2$ $M^+ O_2^-$ Superoxide
Li - ✓	Li - X	Li - X	Li - X
Na - ✓	Na - ✓	Na - X	Na - X
K - ✓	K - ✓	K - ✓	K - ✓
Rb - ✓	Rb - ✓	Rb - ✓	Rb - ✓
Cs - ✓	Cs - ✓	Cs - ✓	Cs - ✓

### Oxide :-

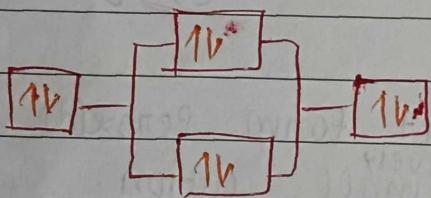
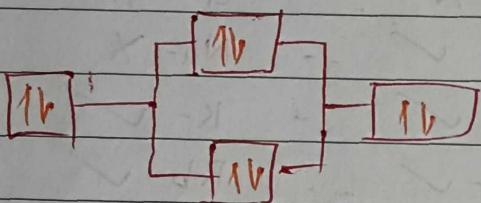
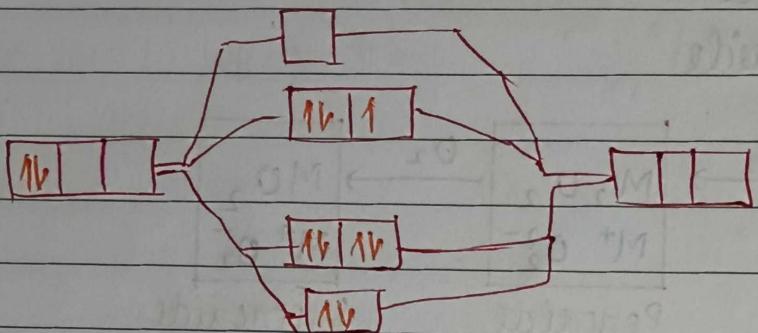
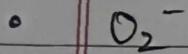


Li can't form Peroxide due to relatively small cation.

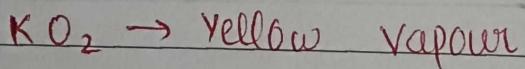
Li and Na can't form Superoxide due to small cation.



Peroxides are dimagnetic



Superoxides are paramagnetic



## "Chemical Properties of Alkali Metals":

### 1. with Hydrogen

- Only Alkali metals and Alkaline Earth Metals can react with hydrogen to form Hydrides  $H^-$ .

$Li^+ H^- < Na^+ H^- < K^+ H^- < Rb^+ H^- < Cs^+ H^-$   
Order of Reducing agent.

- Down the group, reducing agent  $\uparrow$

Hydralith  $\rightarrow CaH_2$

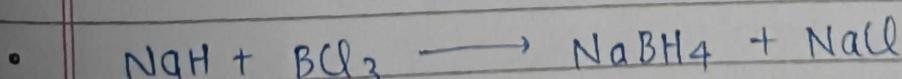
- They are strong reducing agent gives either  $H^-$  or  $H_2$ .



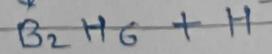
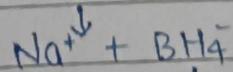
Lithium Alumino

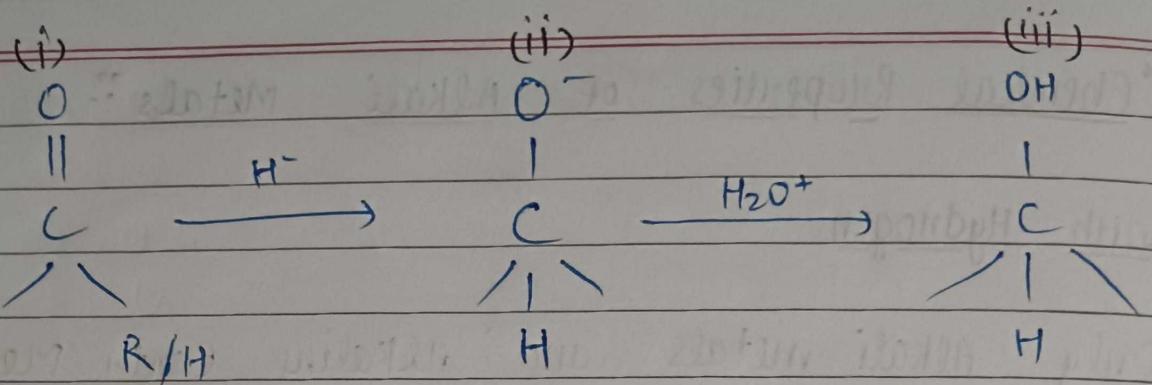
Hydride

Strong reducing agent



Sodium Boride Hydride



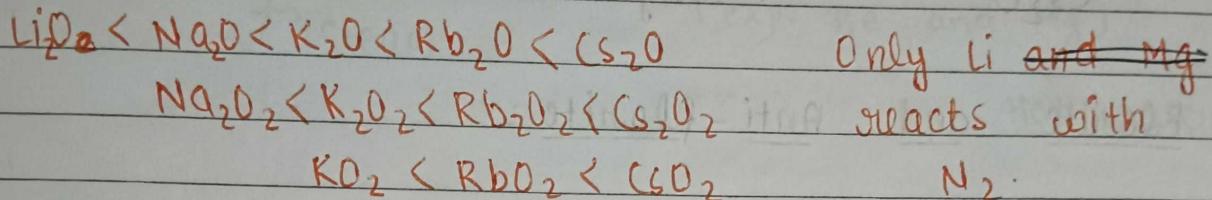
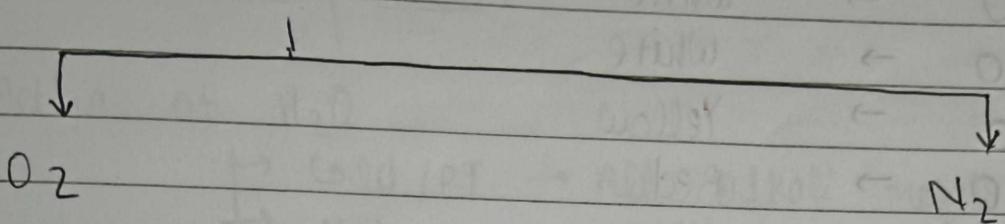


Carbonyl group  
Aldehyde / Ketone

$\text{R} \rightarrow$

- (i) In this carbonyl group only two compounds can be formed i.e. Aldehyde or Ketone.  
If  $\text{H}^-$  is added  $\rightarrow$  Aldehyde  
If  $\text{H}_2\text{O}^+$  is added  $\rightarrow$  Ketone
- (ii) Now, after adding  $\text{H}^-$ ,  $\text{H}$  is ~~attracted~~ attracted towards carbon and shifted just below it.
- (iii) After Hydrolysis,  $\text{OH}^-$  is formed above carbon and  $\text{H}$  is still below it.

## 2. Action of Air:-

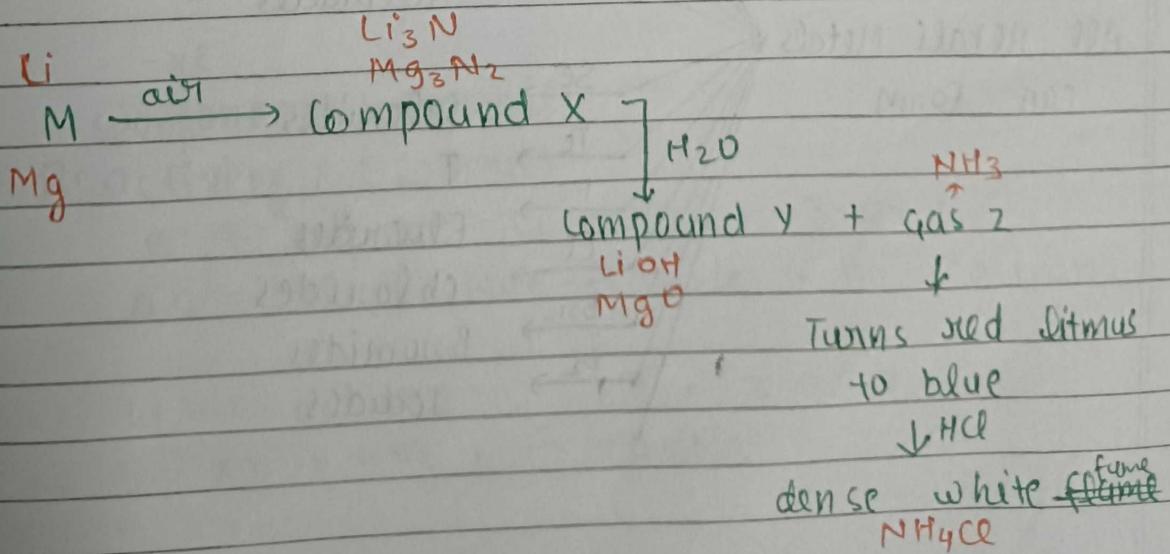


All are basic Li forms  $Li_3N$ .

Ruby Red color.

Li

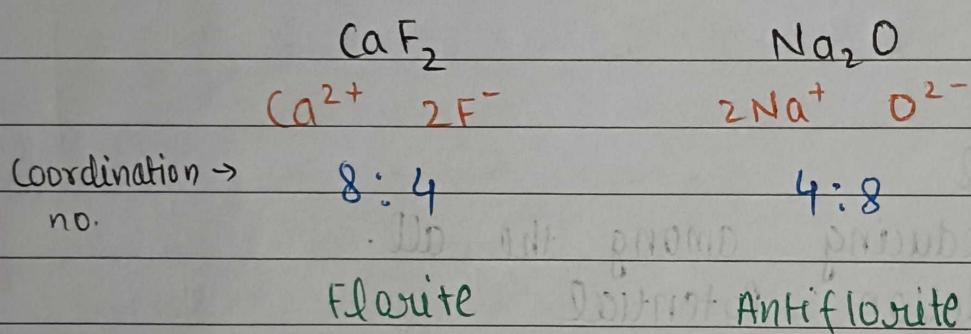
- Highest metal
- Strongest reducing among the all.
- Highest Oxidation Potential
- First member of Electrochemical series
- Highest hydration enthalpy ( $\Delta_{H,H}$ )
- Exceptionally Hard
- Maximum tendency towards Hydrated ion formation
- least mobility of ion in aqueous medium.



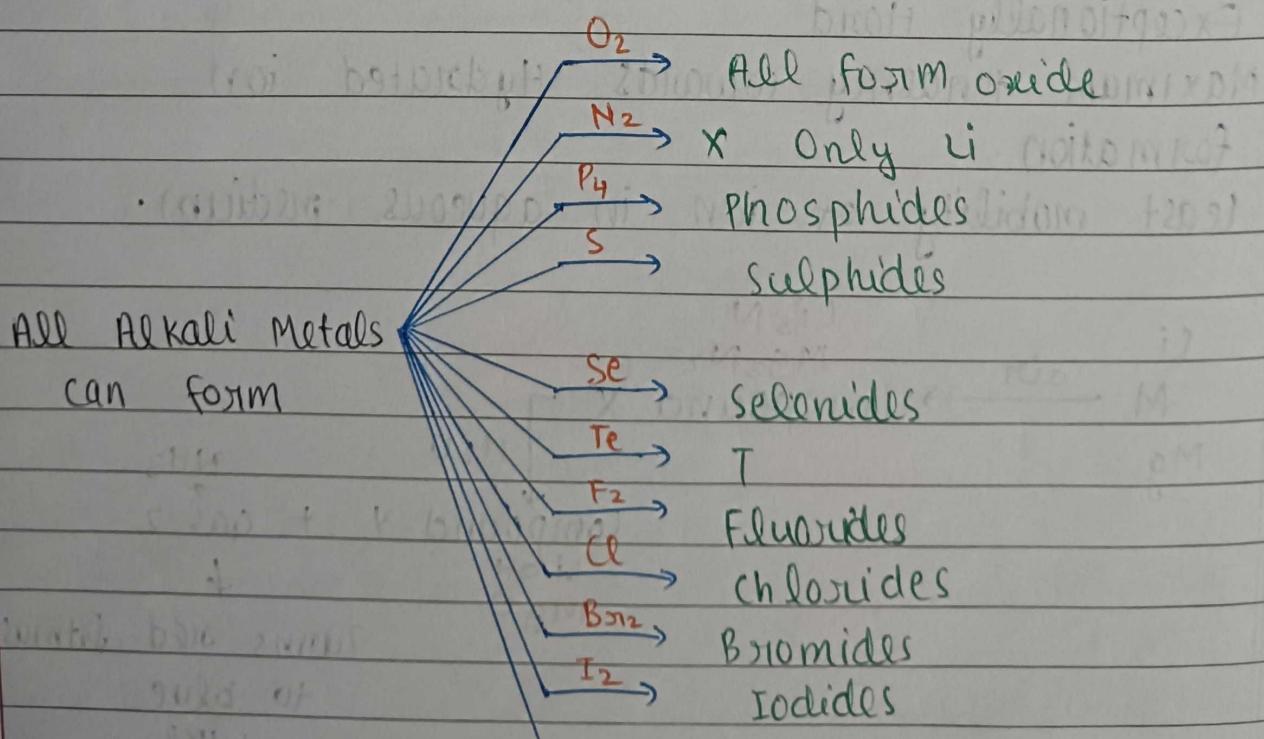
$\text{Li}_2\text{O}$	$\rightarrow$	white
$\text{Na}_2\text{O}$	$\rightarrow$	white
$\text{K}_2\text{O}$	$\rightarrow$	Yellow
$\text{Rb}_2\text{O}$	$\rightarrow$	Red
$\text{Cs}_2\text{O}$	$\rightarrow$	Orange

Florite and Anti-florite :-

Coordination number  $\rightarrow$  An atom is surrounded by  $\downarrow$  how much atoms, is its coordination number.



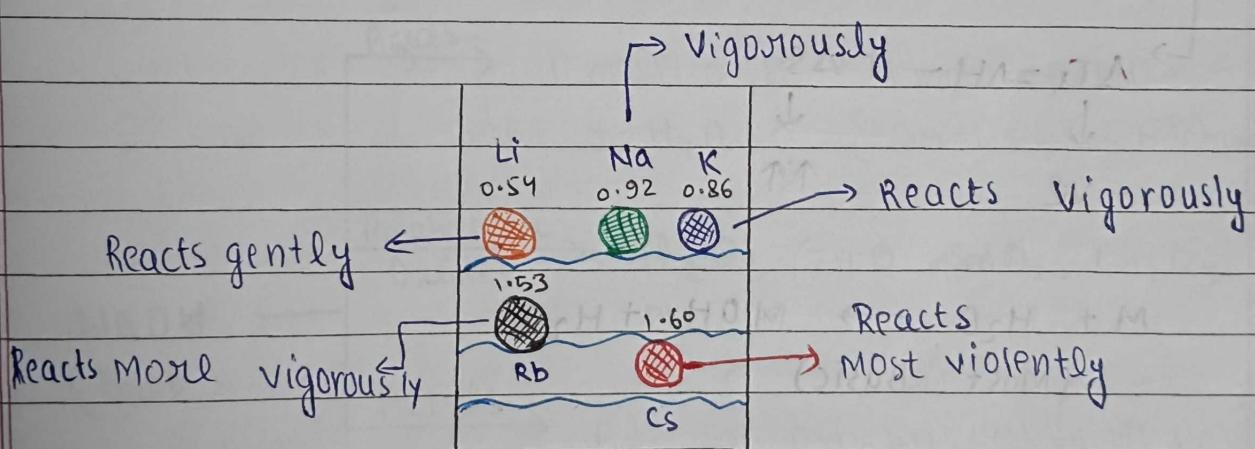
All Alkali Metal oxides are Anti-florite



### 3. Reaction with water:-

#### • Action of $H_2O$

→ Cold / RT → All Alkali metals can react with cold water  
 → Hot (exp. Be and Mg)  
 → Steam ↓  
 Hot water.



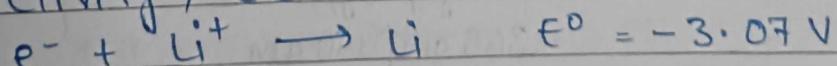
$$\Delta G^\circ = -n F E^\circ$$

↓

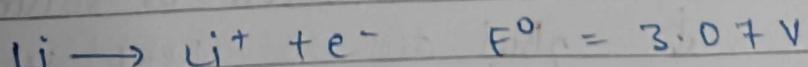
-ve

spontaneous / feasible

Reactivity / EC series

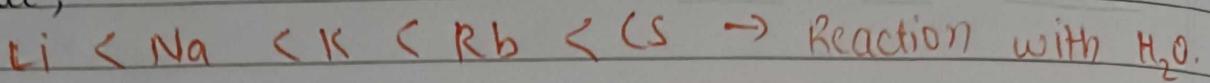


$\Delta G = +ve$ , Non-feasible - no reaction



$\Delta G = -ve \rightarrow$  feasible

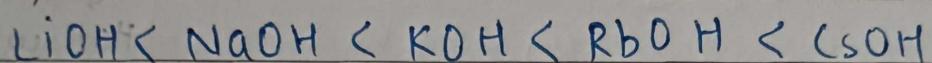
But,



This is because down the group,

• Melting point  $\downarrow$ . Hence, Reaction with  $\text{H}_2\text{O} \uparrow$ .

Hence,



Order of Basicity (All are Alkali).

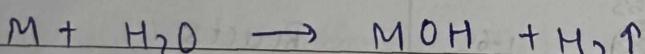
→ High M.P. of Li  $\xrightarrow[\text{released}]{\text{Heat}}$  Utilise to melt it

rest Na, K, Rb, Cs  $\rightarrow$  M.P.  $\uparrow$

$$\Delta G = \Delta H - T \Delta S$$

$$\downarrow \quad \downarrow$$

$$-\text{ve} \quad \uparrow \uparrow$$



(Most Basic)

### Order of Solubility

Li

13.6 gm/100gm

Na

108 gm/100 gm

K

112 gm/100 gm

Rb

197 gm/100 gm

Cs

365 gm/100 gm

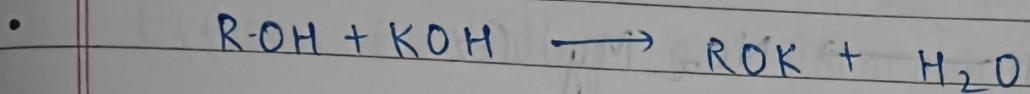
↓ group

↓ solubility ↑

NaOH and KOH can be used as solvents

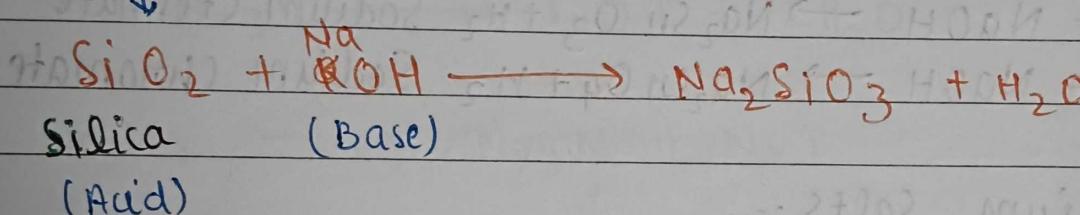
Caustic Soda      Caustic Potash } But due to cheap cost NaOH is used.

- In organic, KOH is used as solvent

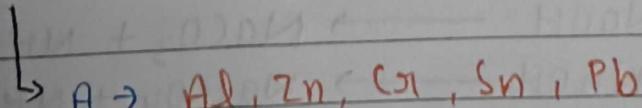
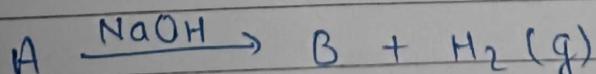
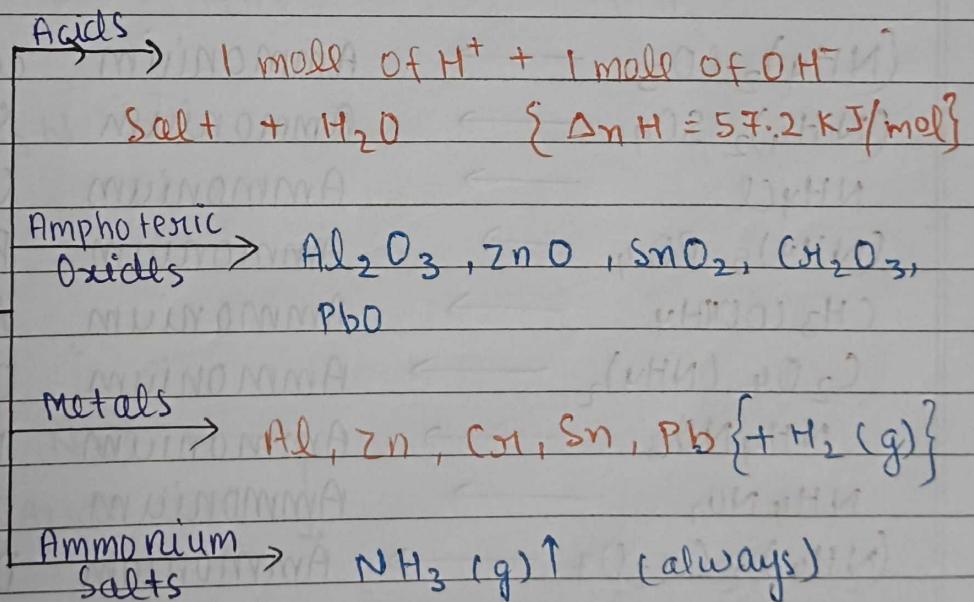


- KOH corrosive in nature on skin as well as glass.

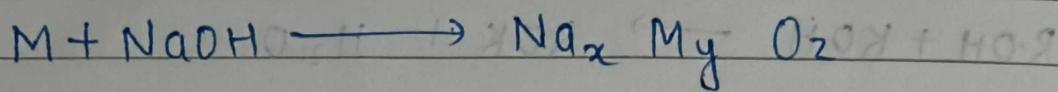
→ Class



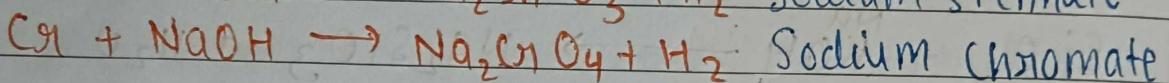
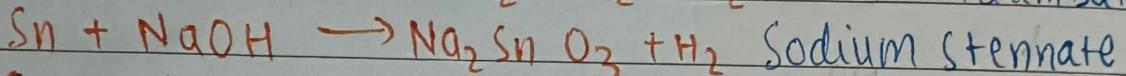
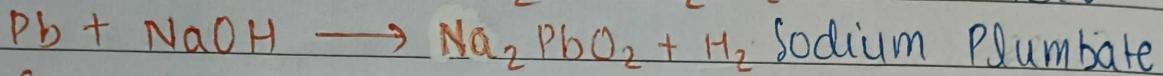
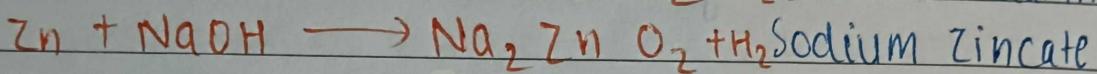
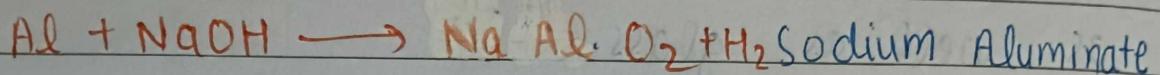
NaOH  
H<sub>2</sub>O  
Base



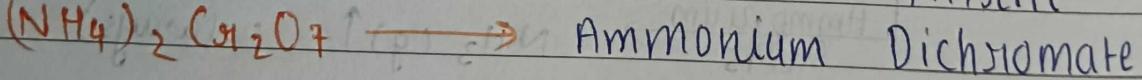
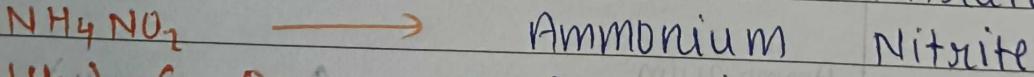
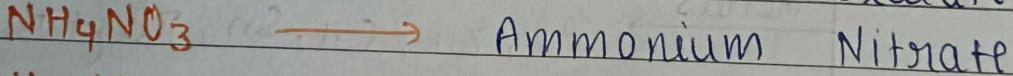
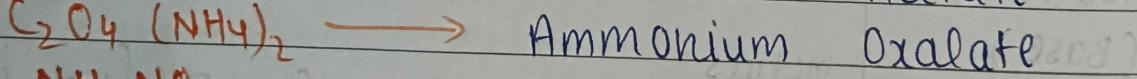
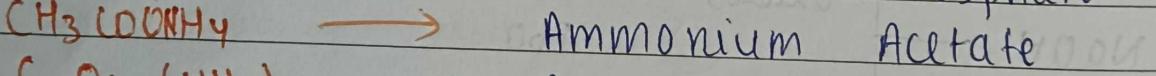
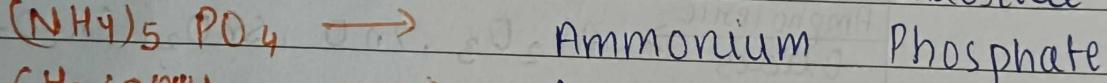
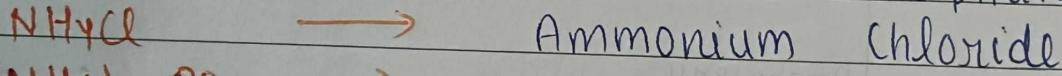
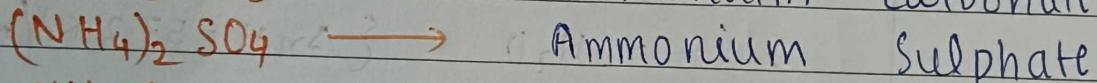
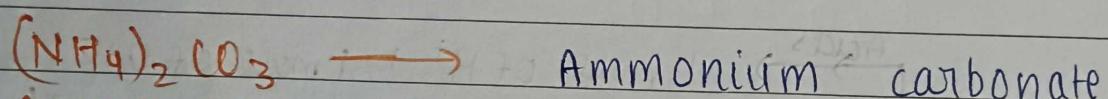
#### 4. Amphoteric Metals with Alkali



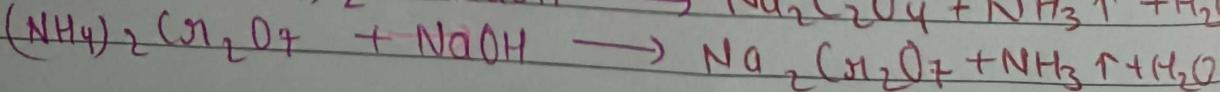
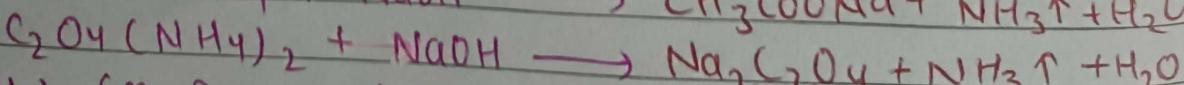
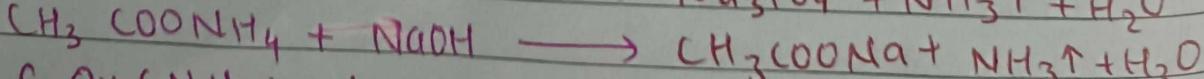
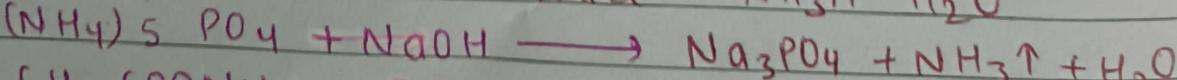
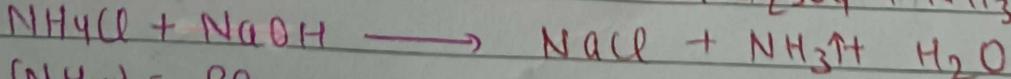
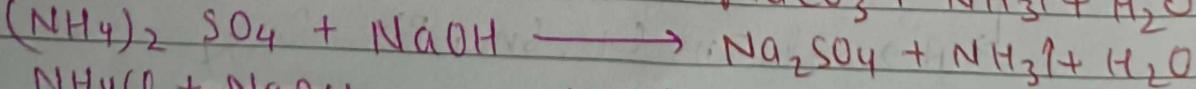
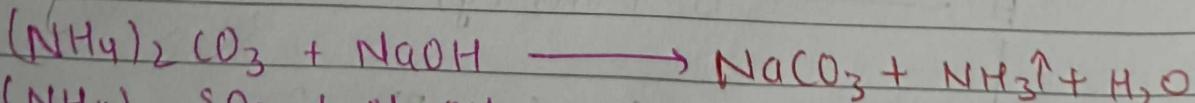
eg:-

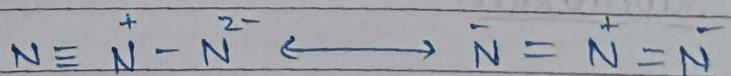
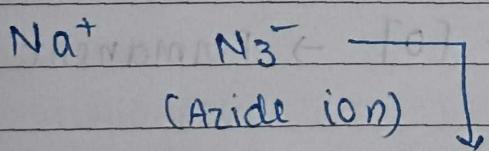
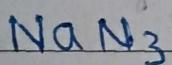
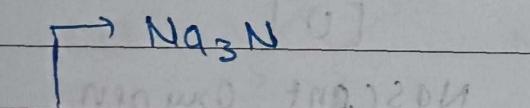
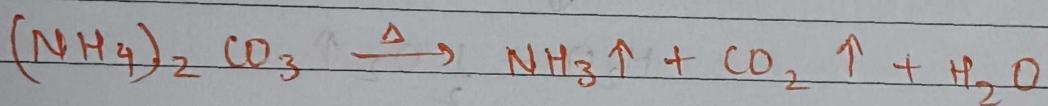
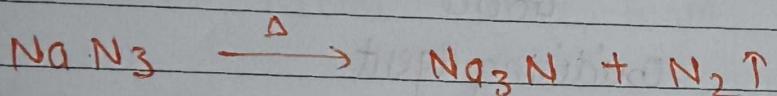
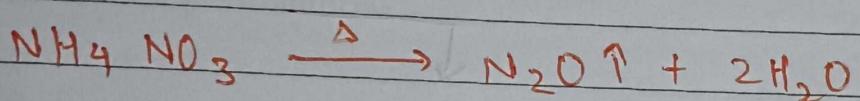
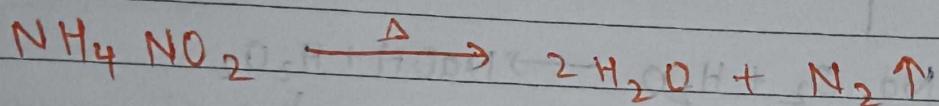
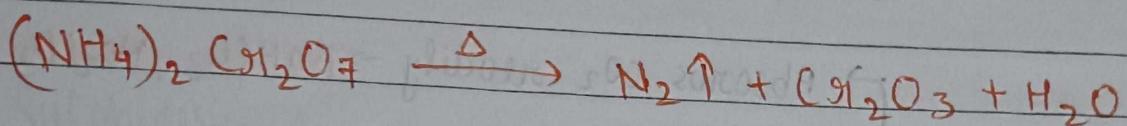
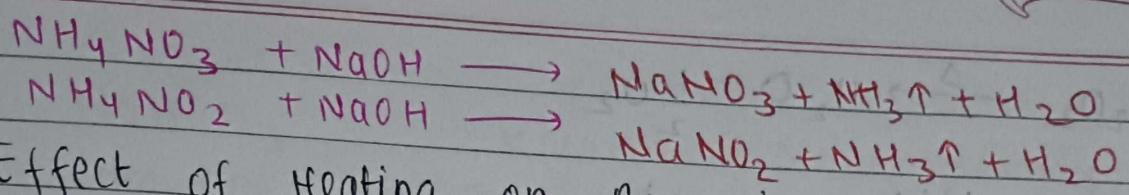


#### 5. Ammonium Salts :-

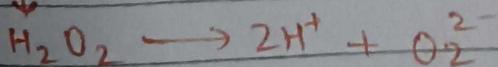
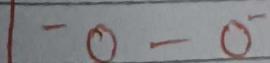
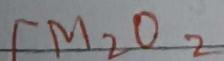


#### Reactions with NaOH :-

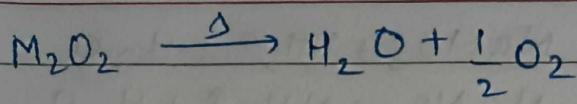




Peroxide :-

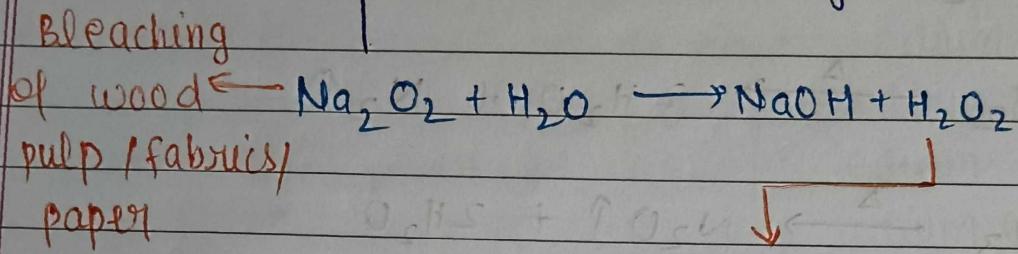


Hydrogen  
Peroxide



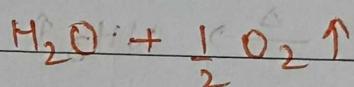
(Oxidising agent)

→ Absorbs  $CO_2$  readily  $\rightarrow NaHCO_3, Na_2CO_3$



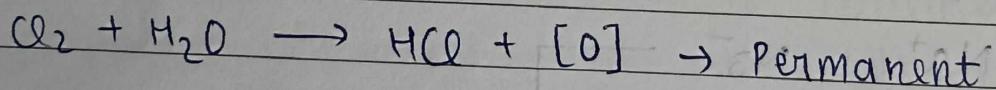
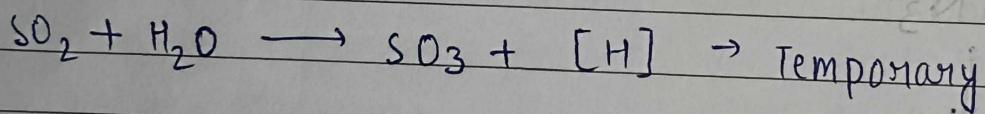
Good

Oxidising Agent

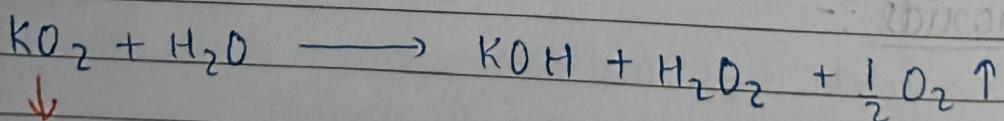
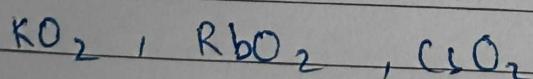


[O]

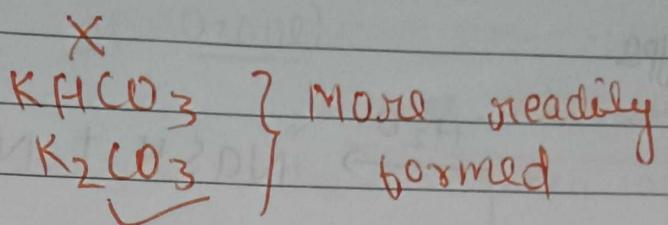
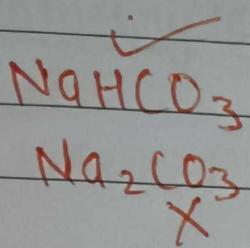
Nascent Oxygen



Superoxide:-



Paramagnetic  
Unpaired  $e^-$       } absorbs  $CO_2$   
                        } readily.

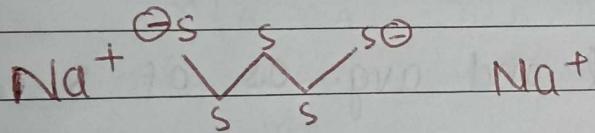
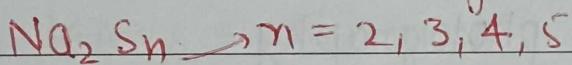


## Sulphides :-

Action of Sulphides:-

All the Alkali metals can form soluble sulphides.

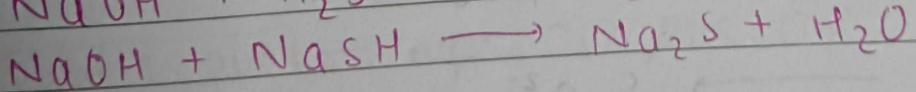
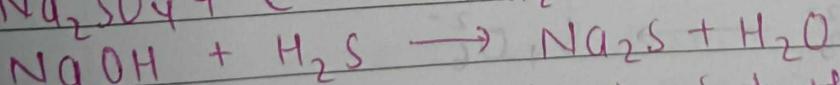
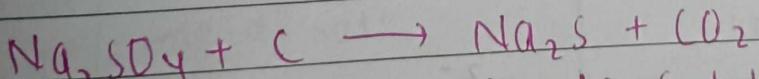
~~So~~ Sodium can form polysulphides.



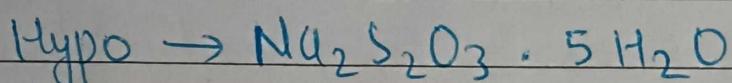
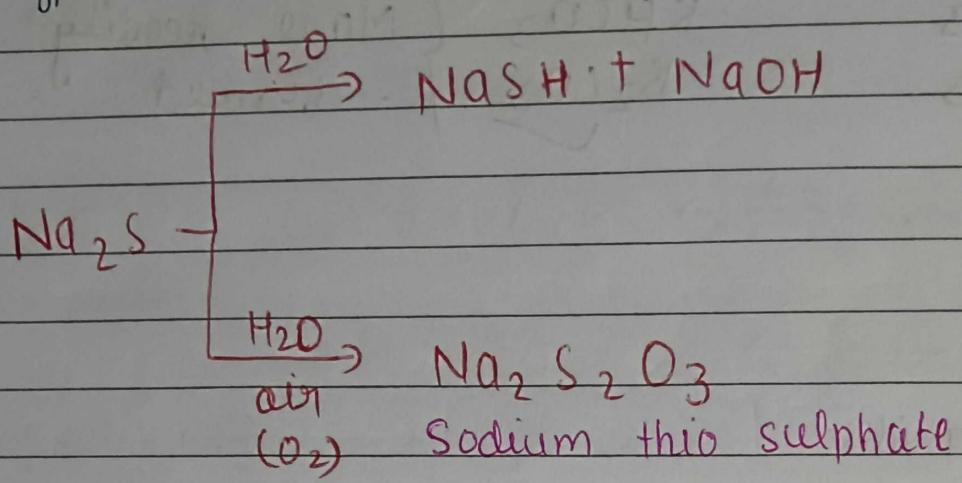
All the sulphides are water soluble.

Down the group, solubility ↑.

~~No~~, Sulphides can be prepared by these three methods:

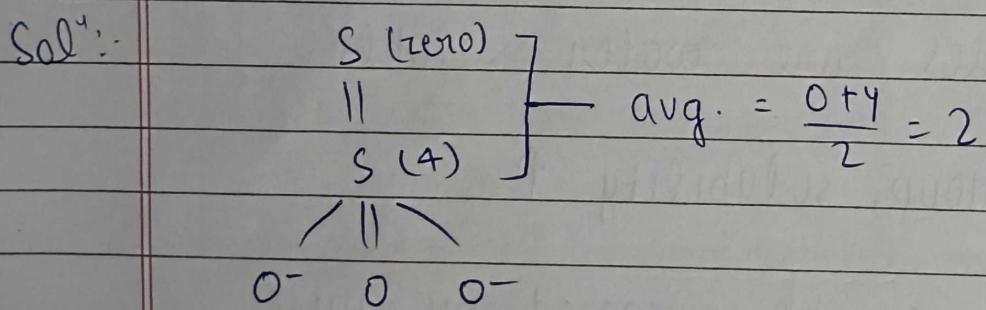


Hypo:-

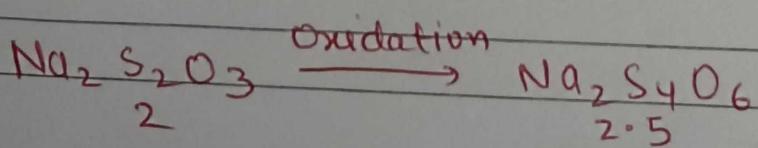
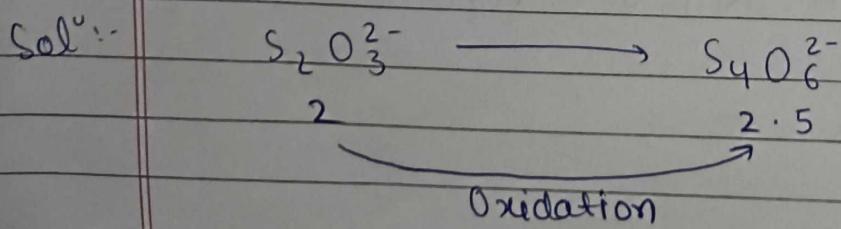
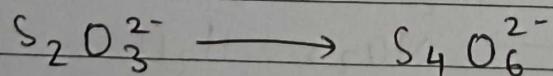


was used in photography.

Q. Find the individual and avg. o.s. of S in Hypo.

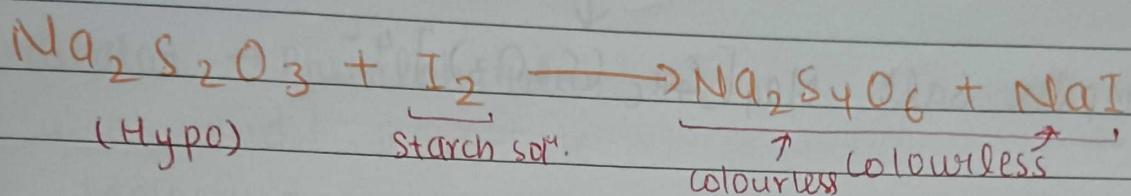
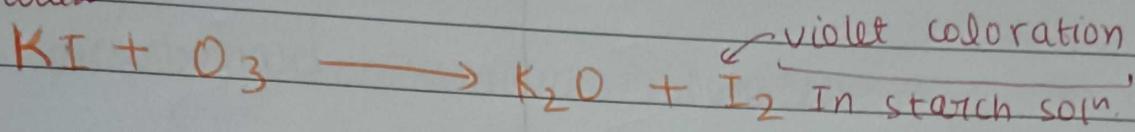


Q. Find the oxidation state of



## Iodometry (Estimation of Ozone) :-

colourless


 Qual  
tativ  
Anal

$$\left. \begin{array}{l} \text{Eq. of } O_3 = \text{Eq. of } I_2 \\ \text{Eq. of } I_2 = \text{Eq. of Hypo} \end{array} \right\} \begin{array}{l} \text{Quantitative} \\ \text{Analysis} \end{array}$$

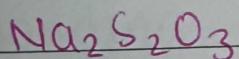
$$\text{Eq. of A} = \text{Eq. of B}$$

$$N_A V_A = N_B V_B$$

$$n_f A M_A V_A = n_f B M_B V_B$$

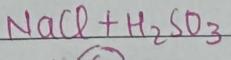
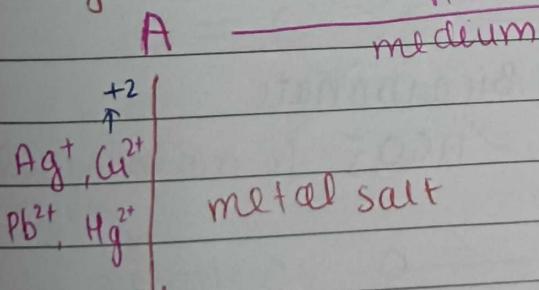
$$n_f A n_A = n_f B n_B$$

$$\frac{n_f A w_A}{M_A} = \frac{n_f B w_B}{M_B}$$



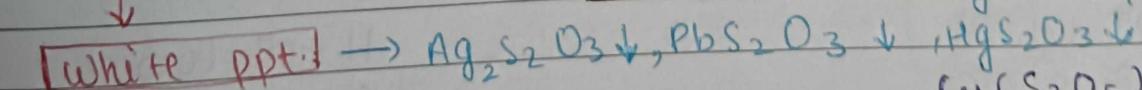
"White"

(Crystalline Compn.)


 $\uparrow(S)$   
 "white turbidity"

 $\xrightarrow{\text{heating}}$   $SO_2 \uparrow + H_2O$   
 "burning sulphur smell"

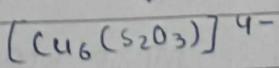
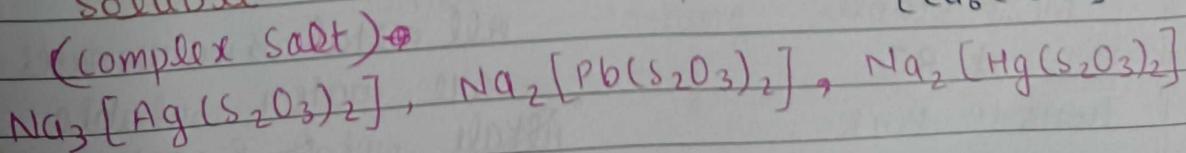
key points -

 white turbidity  $\rightarrow$  sulphur

 $\downarrow$   
 Excess of

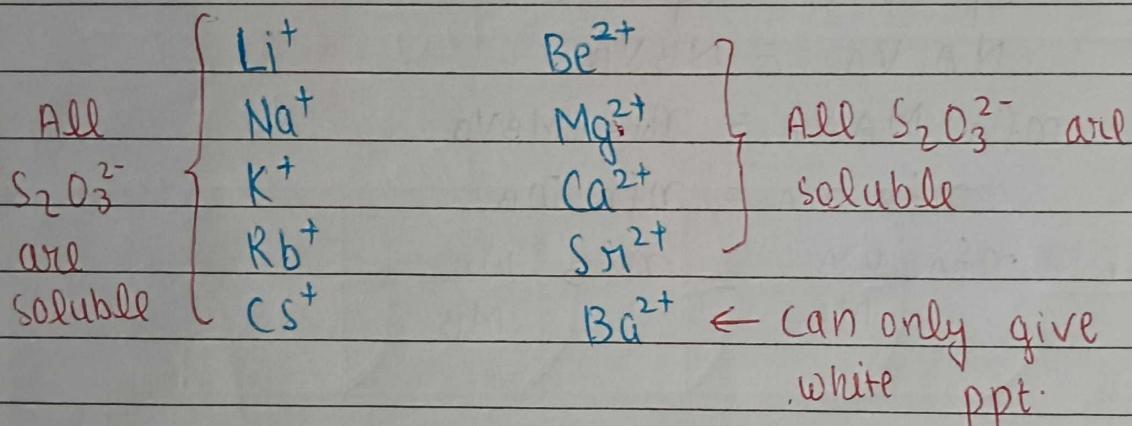
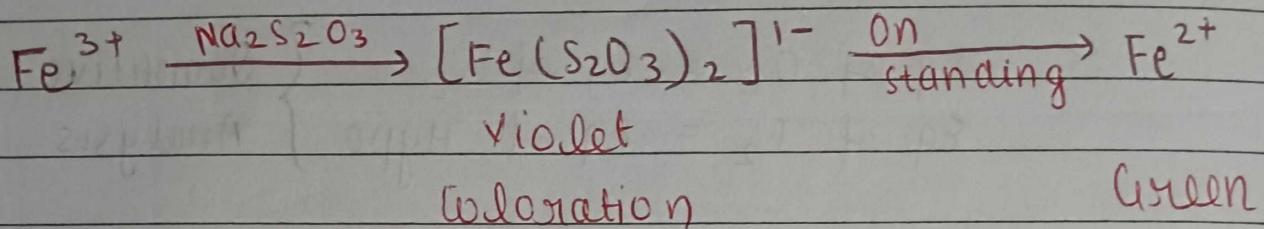
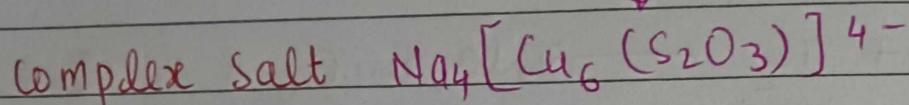
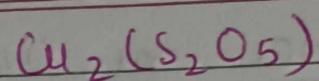
 $(Cu_2(S_2O_5)) \leftarrow \text{Exp.}$   
 $\downarrow$   
 white ppt.  
 $\downarrow$ 

"soluble"

(Complex Salt)

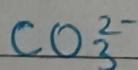


white ppt.



## Carbonates and Bicarbonates

### Carbonate



pH High  
 $\approx 10$



II

C

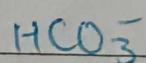


More stable

at R.T.

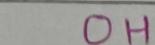
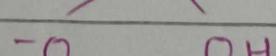
Turns to pink

### Bicarbonate



II pH Low

C ≈ 8



All metal Bicarbonates are water soluble

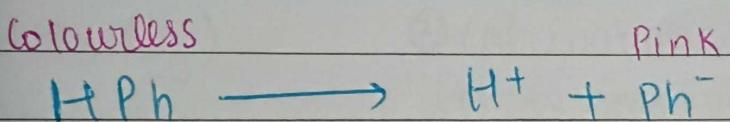
"~~Alkali metal Bicarbonates are water soluble~~"

## Alkali

~~All~~ metal bicarbonates are stable and solid at R.T.

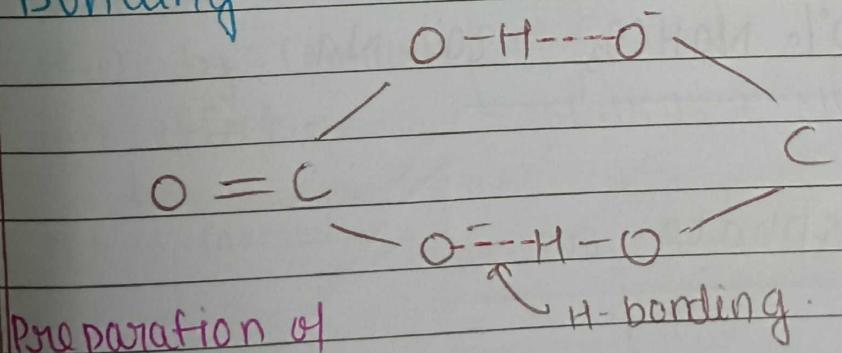
All bicarbonates remain colourless.

- Indicator → Phenolphthalein Test  
 + Weak Acid | Weak Base  
 Compound → Ionic  
 Colour difference



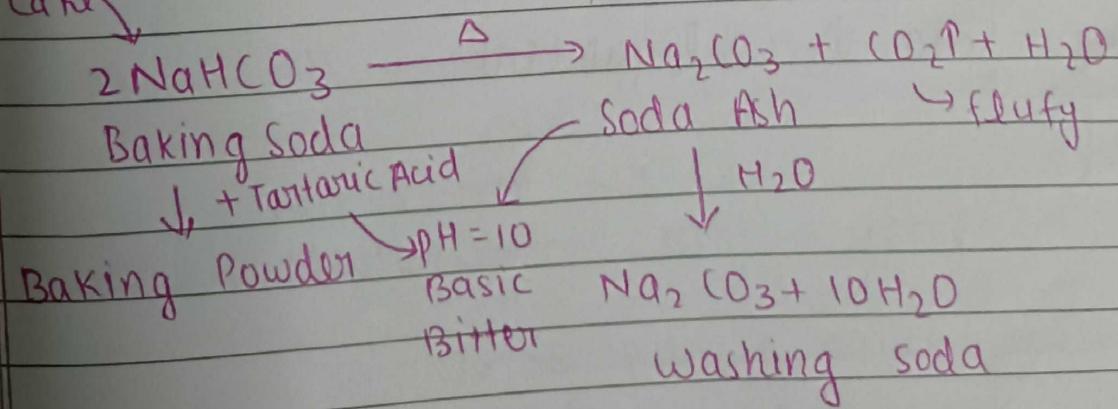
Bicarbonates solubility increases down the group.  
 Therefore,  $\text{NaHCO}_3$  is more stable than  $\text{KHCO}_3$  in solid state.

Both  $\text{NaHCO}_3$  and  $\text{KHCO}_3$  have Hydrogen Bonding.



## Preparation of

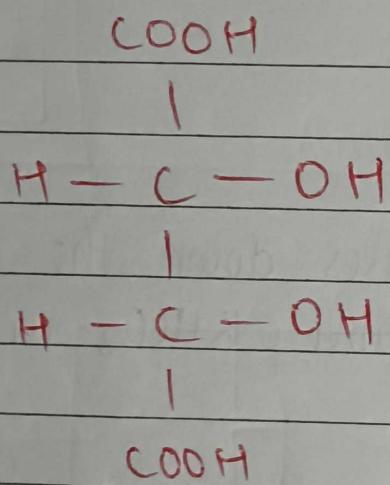
Cakey



Tartaric Acid is used to balance the pH because pH of  $\text{Na}_2\text{CO}_3$  is 10 which causes bitterness in cake. So, instead of Baking Soda, Baking Powder is used.

$\downarrow$   
Baking soda + Tartaric Acid

Tartaric Acid :-



Improved Baking Powder  $\rightarrow$  To delay the release of  $\text{CO}_2$

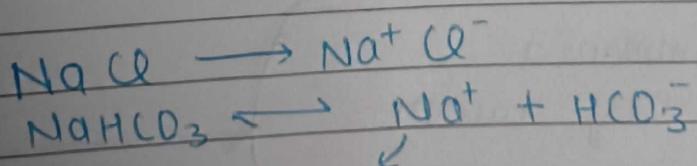
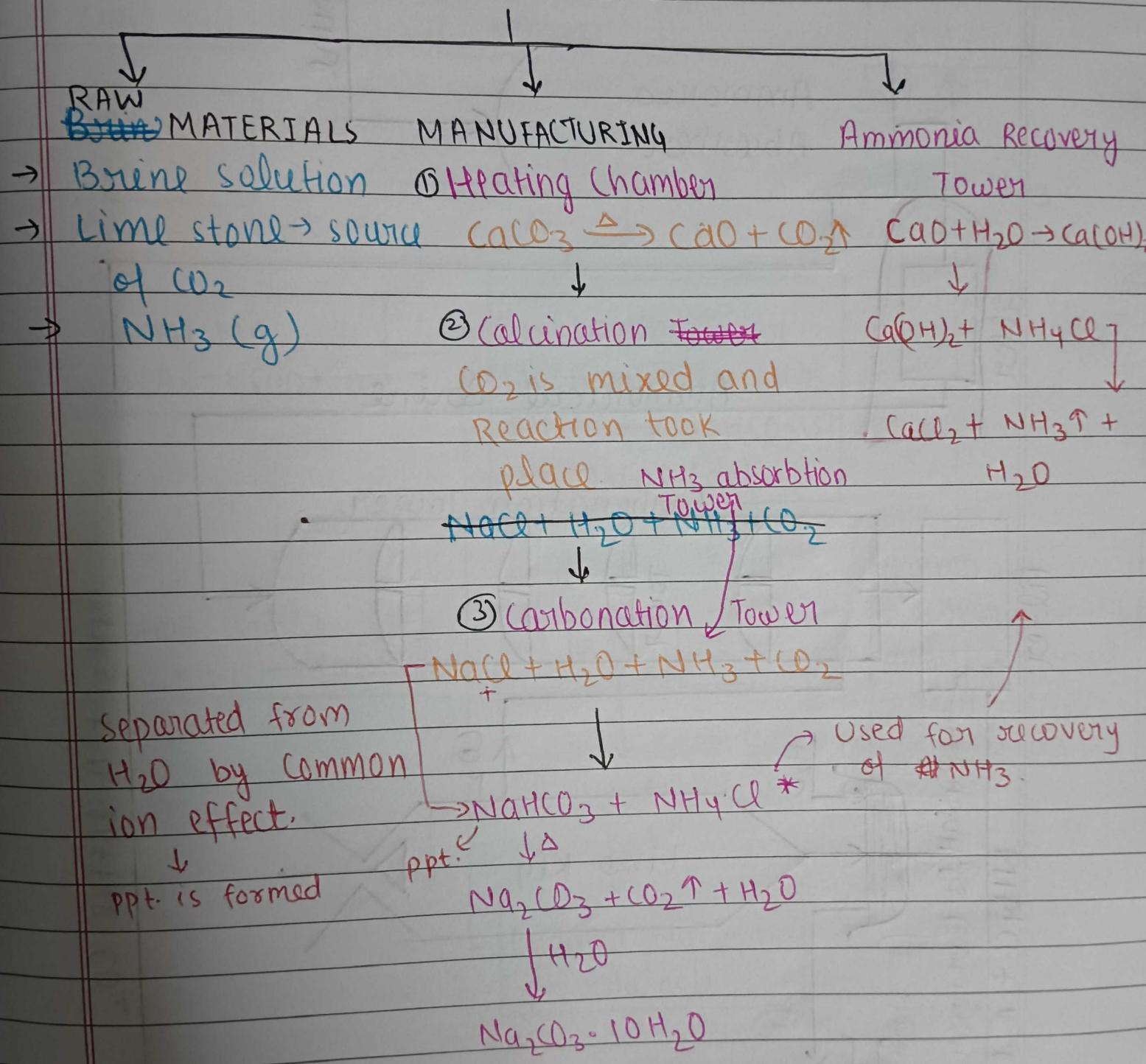
40% starch, 30%  $\text{NaHCO}_3$ , 20% Na, 10%  $\text{NaH}_2\text{PO}_4$ .

$\downarrow$   
Sodium Biphosphate

washing soda is deliquescent.

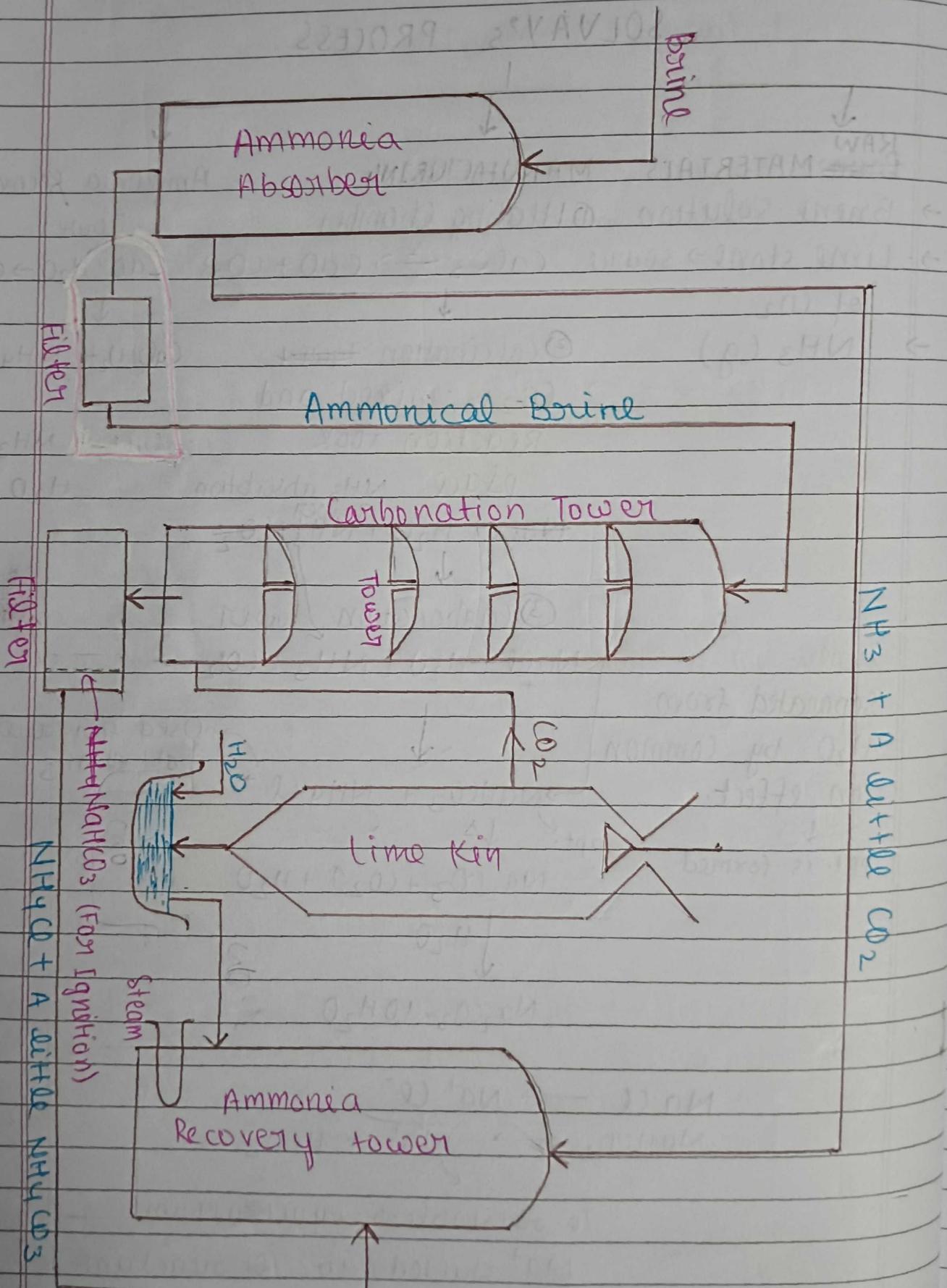
# Manufacturing of Washing Soda

## SOLVAY'S PROCESS

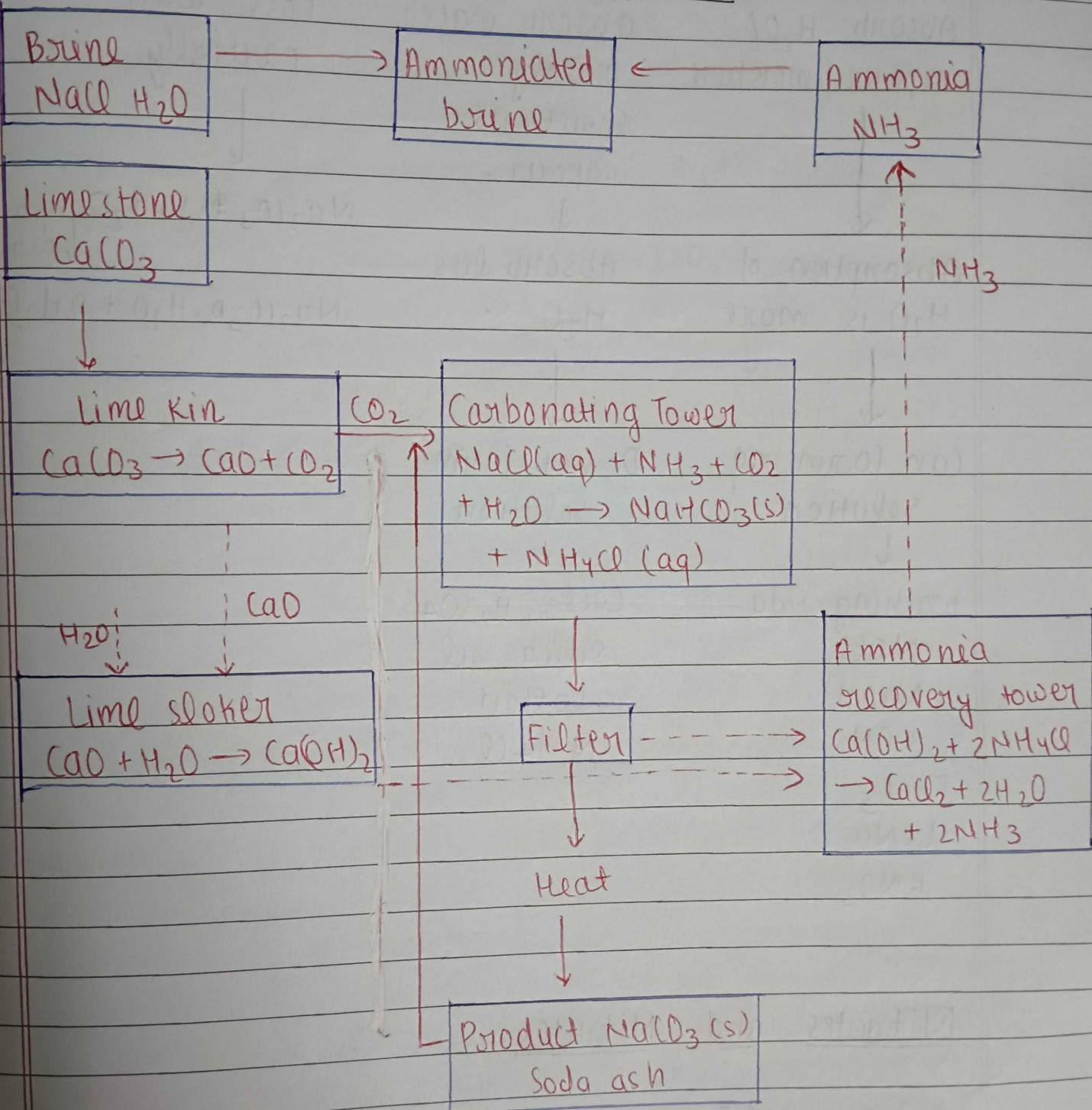


To reestablish equilibrium  
 $\text{Na}^+$  shifted to reactant side.

## Salvay Process + Ammonium



## Solvay Process - Flow Chart



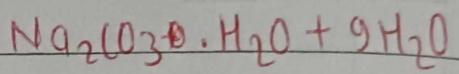
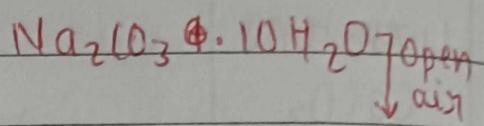
Deliquescent  
Absorb  $H_2O$ /  
vapour / moisture

Hygroscopic  
Absorb water  
mainly  
Sometimes  
vapour

Efflorescent  
Loss water  
partially

Absorption of  
 $H_2O$  is more

Absorb less  
 $H_2O$



Can form soln.

Do not form  
solution

washing soda

$CaCl_2, H_2SO_4$

NaCl

silica gel

NaOH

cotton

KOH

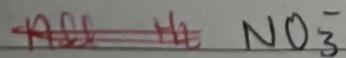
$NH_4Cl$

$FeCl_3$

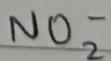
$LiNO_3$

$KNO_3$

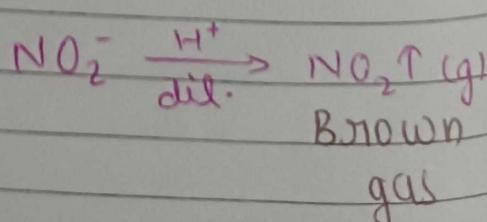
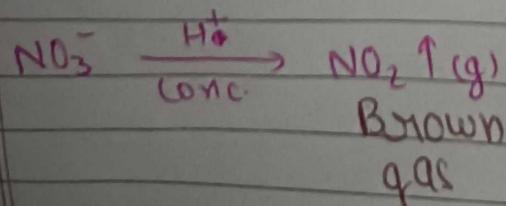
## Nitrates and Nitrates:-

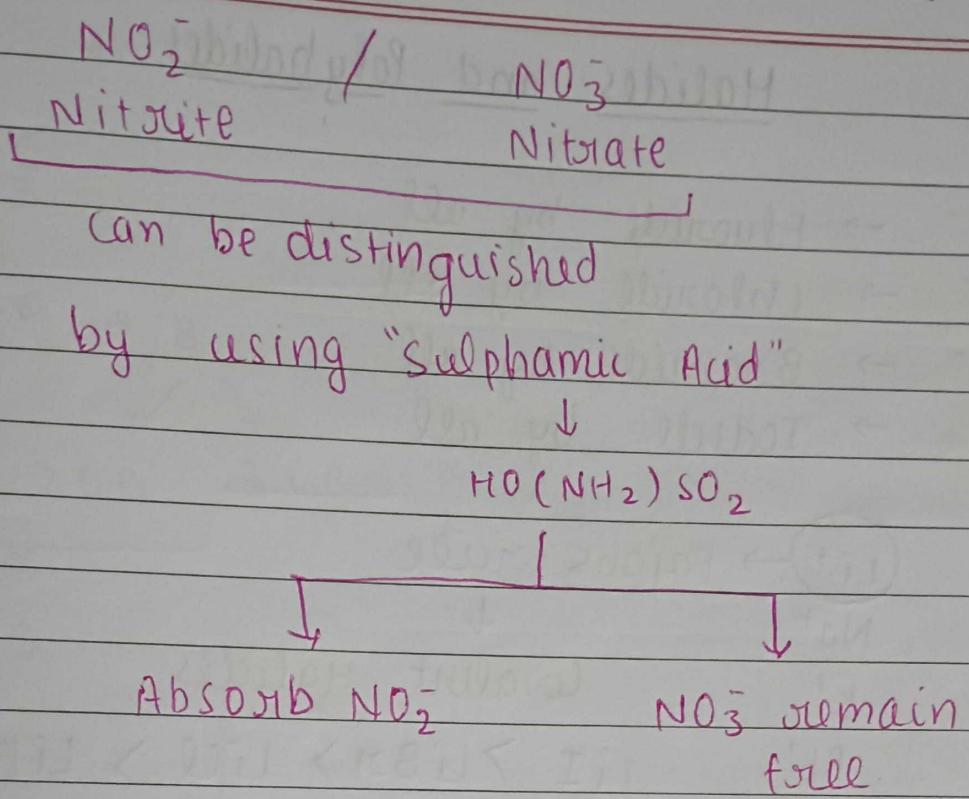


All the Nitrates are  
water soluble.

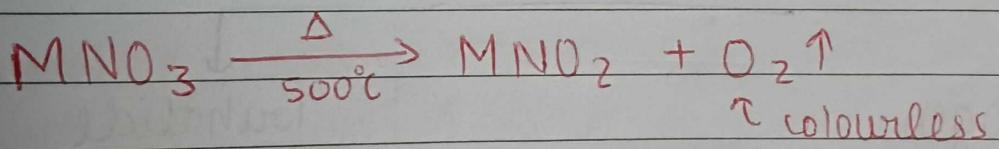


All the nitrates  
except  $AgNO_2$  are  
water soluble.

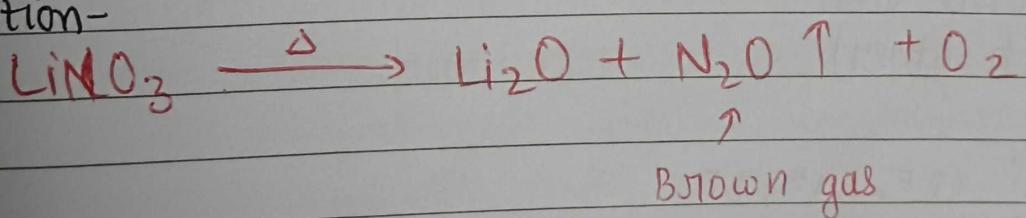




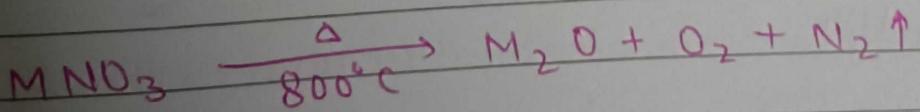
All alkali metal nitrates are highly stable except lithium.



Exception-



"In inorganic chemistry temperature upto  $500^\circ\text{C}$  is considered as normal heating".



## Halides and Polyhalides

$F^- \rightarrow$  Fluoride by all

$Cl^- \rightarrow$  Chloride by all

$Br^- \rightarrow$  Bromide by all

$I^- \rightarrow$  Iodide by all

$Li^+$  → Fajan's rule

$Na^+$

$K^+$

$Rb^+$

$Cs^+$

↓  
Covalent Halides

$LiI > LiBr > LiCl > LiF$

Polyhalides :-

↓  
Interhalogen  
compound  
(combine with  
each other)

↓  
Trihalide

$I_3^-$

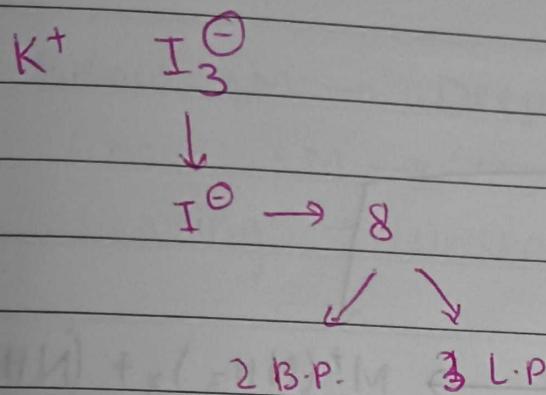
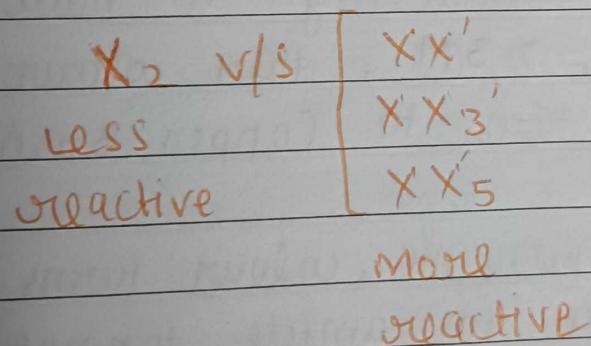
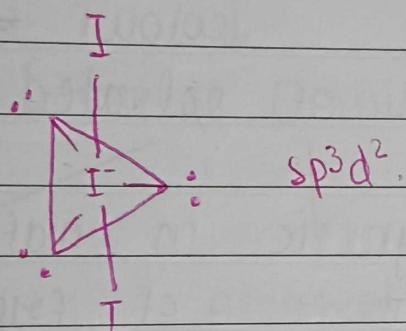
$XX'$   $ClF, BrF, IF$

$XX_3$   $ClF_3, BrF_3, IF_3$

$XX_5$   $BrF_5, IF_5$

$XX_7$   $IF_7$

↓  
More reactive

$KI_3$  $AB_2L_3$ 

### Action of Liquid Ammonia

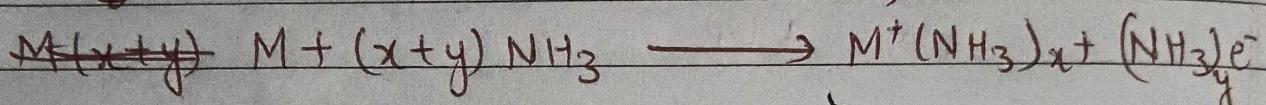
with the impurities  
of Fe.  
Solubility  $\downarrow$

With pure  $NH_3$   
Solubility is  
exceptionally  
high

In pure  $\text{NH}_3$  solubility is exceptionally high due to formation of

Ammoniated Metal ions

Ammoniated  $e^-$



① It is deep blue colour due to

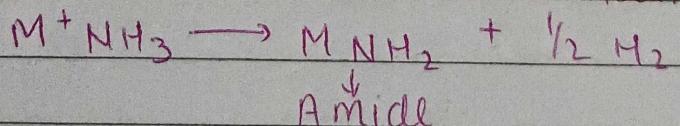
presence of solvated or ammoniate  $e^-$

② Paramagnetic in nature due to presence of free  $e^-$

③ Highly conducting in nature  $\equiv M$

If conc.  $> 3\text{M}$ , then colour of solution turns to Copper Bronze colour.

④ After some time, colour turns to fade due to amide formation.



⑤ The deep blue colour is due to excitation of  $e^-$  from s to p.

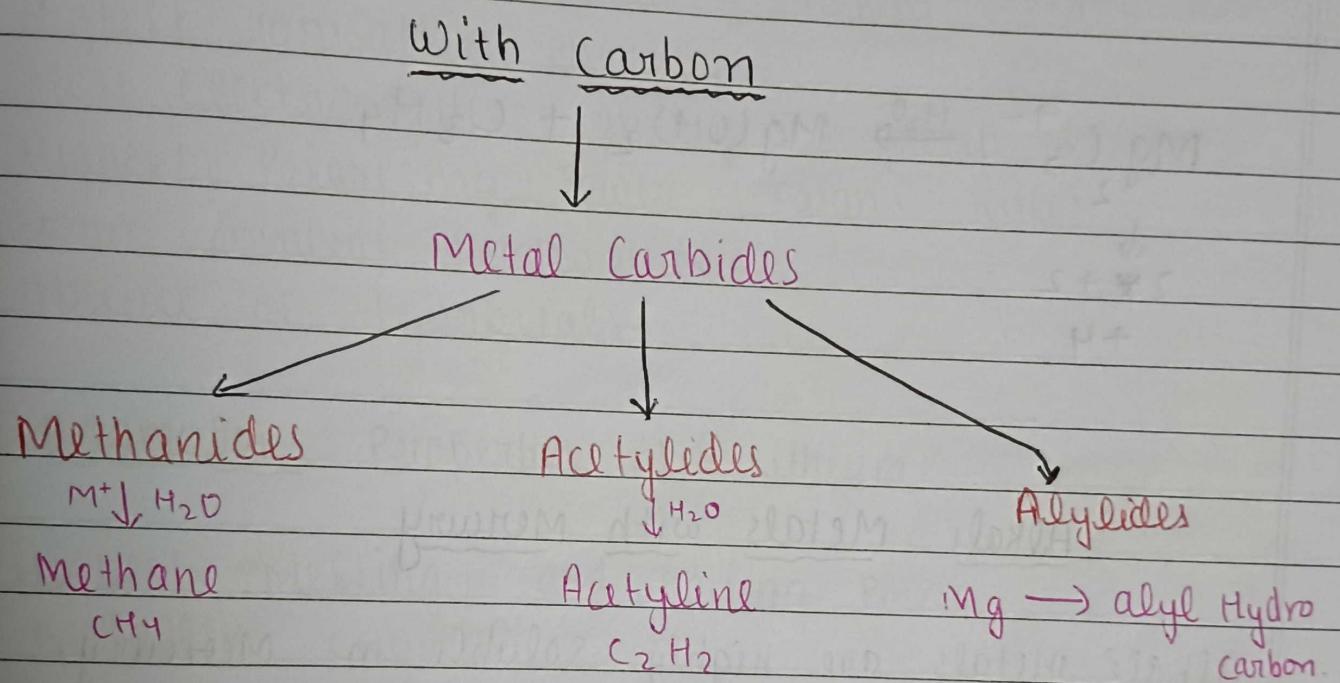
with impurities of Fe



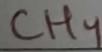
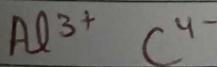
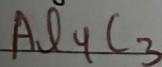
Low solubility  
easy to form amides

## Important Role of concentration:-

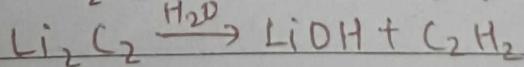
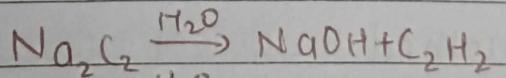
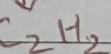
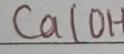
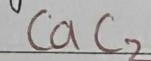
- Below 3M → Deep Blue
- Above 3M → Copper Bronze.
- On heating → Unstable



eg:-



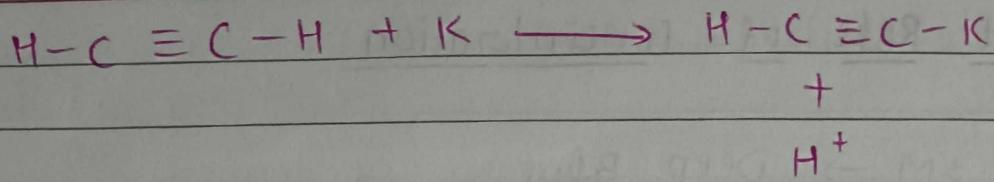
eg:-



Only Li and Na can form carbides which on hydrolysis give Acetylene.

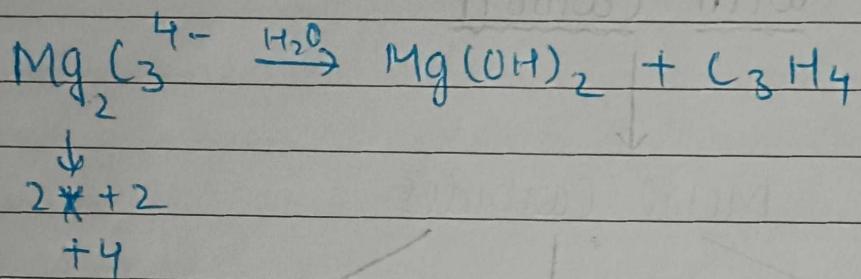
Alkyne > Alkene > Alkane

$\text{sp} > \text{sp}^2 > \text{sp}^3$



Potassium acetylide

K, Rb, Cs can, form carbide but also



### Alkali Metals with Mercury

- Alkali Metals are highly soluble in Mercury, so they can easily form Amalgam.

- Fe and Pt do not form amalgam due to their crystalline structure.

- Alloys can be formed in two ways:-

→ Intercrystalline Method

→ Vacancy

# Anomalous Behaviour of Li.

- o In the IA group / Alkali Metal group, Li shows exceptional behaviour due to :-
- Smallest in size among Alkali metals
- Highest ionisation energy.
- Most Electronegative among IA group elements.
- Highest Polarising Power (Fajan's Rule)
- Form covalent compounds.
- Absence of d-orbitals.

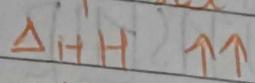
## Anomalous Properties of Lithium:-

- Highest Melting and Boiling Point  
**Metallic crystal**
- Much more harder than others.
- Can only react with  $N_2$  and Si  
 $\hookrightarrow Li_3N$      $\hookrightarrow Li_6Si_2$
- Lighter than other metals.  
**Density = 0.56 gm**
- Least reactive than other metals
- Can form complexes due to  $\Delta_{HH}^{high}$
- Can form oxides but not superoxides/ peroxides  
**Small size**

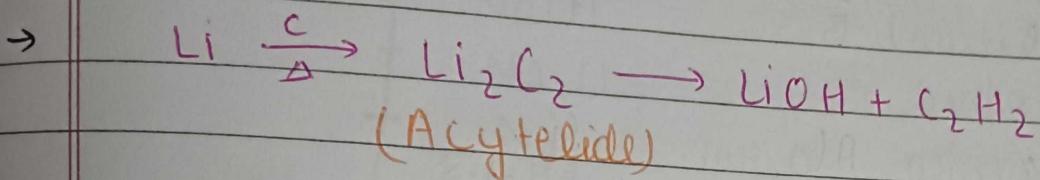
- ~~to~~ carbonates, nitrates, hydroxides easily gives  $\text{CO}_2$ ,  $\text{NO}_2$ ,  $\text{H}_2\text{O}$  on heating  
Thermally unstable
- ↔ →  $\text{Li}_2\text{CO}_3$ ,  $\text{Li}_3\text{PO}_4$ ,  $\text{Li}_3\text{LiF}$  are insoluble in water due to covalent nature.
- $\text{Li}_2\text{O} \xrightarrow{\text{H}_2\text{O}}$  faintly due to high M.P.
- $\text{LiOH}$  least soluble / least basic / low pH
- $\text{LiCl}$  is deliquescent can dissolve in organic solvent like Pyridine or Benzene sufficiently + covalent
- $\text{LiCl}$  is only that can form hydrated salt.  
 $\text{LiCl} \cdot 2\text{H}_2\text{O}$
- Only Lithium Oxide more stable than its carbonate
 
$$\text{Li CO}_3 \rightarrow \text{Li}_2\text{O} + \text{CO}_2$$

$$\text{Li}_2\text{O} > \text{Li CO}_3$$
- $\text{LiNO}_3 \xrightarrow{\Delta} \text{Li}_2\text{O} + \text{NO}_2 + \text{O}_2$
- $\text{NaNO}_3 \xrightarrow{\Delta} \text{NaNO}_2 + \text{O}_2$
- Exceptionally high  $E^\circ$ .  
 $E^\circ_{\text{oxidation}} = 3.04 \text{ eV}$ .

In aq soln



$\text{Li}^+$  aq (stable)



→  $\text{LiClO}_4$  → Soluble in Benzene and Alcohol.  
 Lithium Perchlorate

$\text{ClO}^-$  → Sufficiently covalent  
 Hypo chlorite

$\text{ClO}_2^-$  → Chlorite

$\text{ClO}_3^-$  → Chlorate

$\text{ClO}_4^-$  → Per chlorate

$\text{HClO}^-$  → Hypo chlorous Acid

$\text{HClO}_2^-$  → Chlorous Acid

$\text{HClO}_3^-$  → Chloric Acid

$\text{HClO}_4$  → Per chloric Acid.

→  $\text{LiSH}$  is unstable

→ Lithium does not form Alum

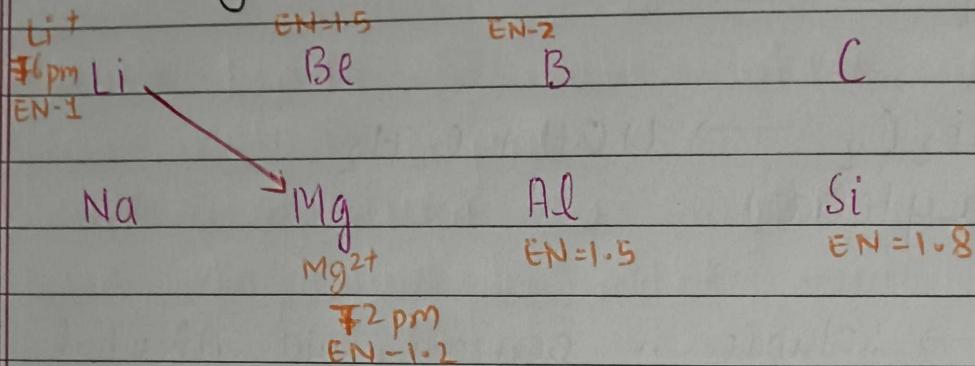
Gen. formula  $\rightarrow \text{M}_2\text{SO}_4 \cdot \text{M}_2(\text{CO}_4)_3 \cdot 24\text{H}_2\text{O}$

+1      +3

Monovalent      Trivalent  
 Na, K, Rb, Cs      Al, Cr, Ni

e.g.  $\rightarrow \text{K}_2\text{SO}_4 \cdot \text{Al}_2(\text{SO}_4)_3 \cdot 24\text{H}_2\text{O}$

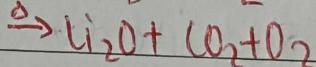
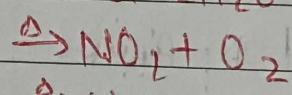
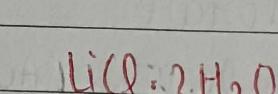
# Diagonal Relationship



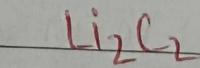
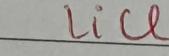
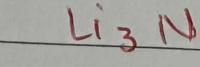
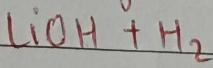
Properties



1. Electronegativity
2. ~~High~~ Polarising Power
3. Ionic Hydrates
4. Nitrates
5. Carbonates
6. M. P.
7. Action of water
8. Action of Nitrogen
9. Action of Chlorine
10. Action of Carbon
11. Action of Air
12. Size of ion
13. Alum formation
14. Solubility of OH<sup>-</sup>



High ( $1300^\circ\text{C}$ )

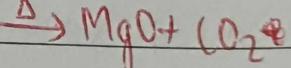
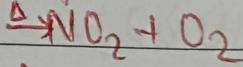
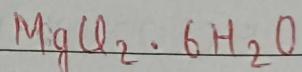


Corrosion

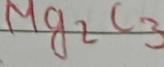
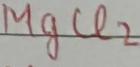
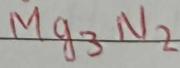
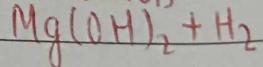
56 pm

NO

Less



High ( $1100^\circ\text{C}$ )



Corrosion

72 pm

No

Less

# Compounds of Alkali Metals

1.

~~NaOH~~

Compounds of Na



NaOH

Na<sub>2</sub>CO<sub>3</sub>Na<sub>2</sub>CO<sub>3</sub> · 10H<sub>2</sub>ONaHCO<sub>3</sub>Na<sub>2</sub>CO<sub>3</sub> · NaHCO<sub>3</sub> · 2H<sub>2</sub>O

Caustic Soda

Soda Ash

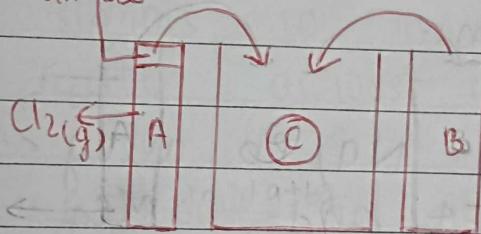
Washing Soda } Solvay's

Baking Soda } Process

Trona

Castner Kelner Cell.

Preparation of NaOH

(Carbon  
anode)

Points to remember:-

1. The formed Na<sup>+</sup> in outer compartment can form Na-Hg.
2. In middle compartment Na-Hg act as anode and Fe as cathode.
3.
 
$$\text{Na-Hg} \longrightarrow \text{Na}^+ + \text{e}^- + \text{Hg}$$

$$2\text{H}_2\text{O} + 2\text{e}^- \longrightarrow \text{H}_2 + 2\text{OH}^-$$

$$\text{Na}^+ + \text{OH}^- \longrightarrow \text{NaOH}$$

## ★ Uses of Lithium:-

1. Used to make useful alloys
  - With Lead to make 'white metal' bearing for motor engine.
  - With aluminium to make aircraft parts
  - With Magnesium to make armour plates.
2. Used in thermonuclear reactions.
3. Used to make electrochemical cells.

## ★ Uses of Sodium:-

1. Used to make  $\text{Na}/\text{Pb}$  alloy needed to make  $\text{PbEt}_4$  and  $\text{PbMe}_4$ .
2. Liquid sodium metal is used as coolant in fast breeder nuclear reactor.

## ★ Uses of Potassium:-

1.  $\text{KCl}$  is used as fertiliser.
2.  $\text{KOH}$  is used in manufacture of soft soap.
3. Also used as an excellent absorber of  $\text{CO}_2$ .

## ★ Uses of Cesium:-

1. Used in devising photoelectric cells.

## Biological Importance of Sodium and Potassium:

- A typical 70 kg man contains 90g of Na and 170 g of K.
- Sodium ion are found primarily on the outside of cells being located in blood plasma and in the interstitial fluid which surrounds the cells.
- These ions participate in transmission of nerve signals, in regulating the flow of water across cell membrane.
- Potassium ions are the abundant cations within cell fluids, where they activate many enzymes, participate in the oxidation of glucose to produce ATP.

	Plasma	RBC
Sodium	143 m mol/L	10 m mol/L
Potassium	5 m mol/L	105 m mol/L

# Alkaline Earth Elements:-

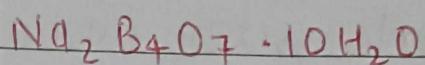
Property	Be	Mg	Ca	Sr	Ba
Atomic No.	4	12	20	38	56
Atomic mass	9.01	24.31	40.08	87.62	137.33
E.C.	[He]2s <sup>2</sup>	[Ne]3s <sup>2</sup>	[Ar]4s <sup>2</sup>	[Kr]5s <sup>2</sup>	[Xe]6s <sup>2</sup>
Ionisation Enth.	899	737	590	549	503
Hydration Enthalpy	-2494	-1921	-1577	-1443	-1305
Metallic radius (pm)	111	160	197	215	222
Ionic radius	31	72	100	118	135
M <sup>2+</sup> (pm)					
M.p. (K)	1560	924	1124	1062	1002
B.P. (K)	2745	1363	1767	1655	20789
Density	1.84	1.74	1.55	2.63	3.59
Standard Potential - E°	-1.97	-2.36	-2.84	-2.89	-2.92

## Some Important Compounds

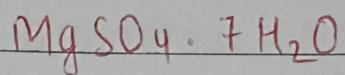
1. Dicalcium silicate  $\text{Ca}_2\text{SiO}_4$
2. Tricalcium silicate  $\text{Ca}_3\text{SiO}_5$
3. Tricalcium Aluminate  $\text{Ca}_3\text{Al}_2\text{O}_6$
4. Gypsum  $\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$
5. Calcium Oxide  $\text{CaO}$
6. Calcium Carbonate  $\text{CaCO}_3$
7. Calcium Hydroxide  $\text{Ca}(\text{OH})_2$
8. Beryllate ion  $[\text{Be}(\text{OH})_4]^{2-}$

compounds

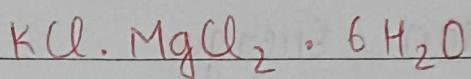
Tincal



Epsum



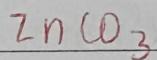
Carnallite



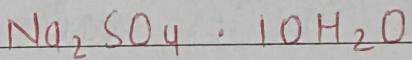
Dolomite



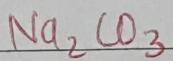
Calamine



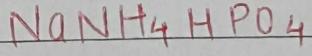
Glauber's salt



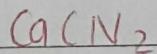
Soda Ash



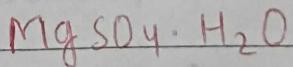
Microcosmic Salt



calcium cyanamide



Kieserite



Fluospar

