* Most electropositive element → Cs
* Best Reducing agent → Li

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S - block

Group IA
alkali metals
ns^1

Group II A
alkaline earth metals
ns^2

Physical Properties

1. **Atomic size and ionic :-**

Li < - - - - - - < Cs	Be < - - - - - < Ba
Li^+ < - - - - - < Cs^+	Be^{2+} < - - - - - < Ba^{2+}

2. **Density :-**

Li < K < Na < Rb < Cs	Ca < Mg < Be < Sr < Ba

due to vacant 3d orbitals there is abrupt ↑ in vol. of K hence d ↓

3. **I.E. :**

Li > - - - > Cs	Be > Mg - - - > Ba
electropositive character $\propto \frac{1}{I.E.}$ Li < - - - < Cs	Be < - - - < Ba

Cs → used in photoelectric cells

4. **Reducing Chr :-**

Na < K < Rb < Cs < Li	Be < Mg < Ca < Sr < Ba

5. **Hydration :-**

Li^+ > Na^+ - - - > Cs^+	Be^{2+} > - - - - > Ba^{2+}
ionic mobility / Conductance $\propto \frac{1}{\text{hydration}}$	
NEET 2017 $Li^+_{(aq)}$ < - - - < $Cs^+_{(aq)}$	$Be^{2+}_{(aq)}$ < - - - < $Ba^{2+}_{(aq)}$
In E.F. Li^+ > - - - - > Cs^+	Be^{2+} > - - - > Ba^{2+}

6. **M.P. :** Li > - - - - > Cs — Be > Ca > Sr > Ba > Mg
   B.P. : Li > - - - - > Cs — Be > Ba > Ca > Sr > Mg

7. **Complex forming tendency :**

Cond^n :-
- size ↓
- Charge density ↑
- Vacant orbital available

Beta Bapu ATE can not! Sorry Madam

only Li form complex

only Be & Mg form complex

$BeF_2 + 2F^- \longrightarrow BeF_4^{2-}$

$Be^{2+} + 4H_2O \longrightarrow [Be(H_2O)_4]^{2+}$

$AlF_3 + 3F^- \longrightarrow AlF_6^{3-}$

Ques Which of the following is not possible ?

① $CF_4 + 2F^- \longrightarrow [CF_6]^{2-}$

② $BF_3 + 3F^{\ominus} \longrightarrow [BF_6]^{3-}$

③ $AlF_3 + 3F^- \longrightarrow [AlF_6]^{3-}$

④ both ① & ②

8. Flame Test :-

Li : Crimson Red

Na : Golden Yellow

K : Pale violet

Rb : Violet

Cs : Blue

(Be & Mg) donot give any color on Flame Test ∵ High I.E.

Ca Brick Red

Sr Dark Red

Ba Apple Green

Chemical Properties

	I A	II A
1.	Reactivity : Li < - - - K Cs	Be < - - - < Ba
2.	Reacⁿ with H / Hydrides: $M + H_2 \xrightarrow{\Delta} MH$	$M + H_2 \xrightarrow{\Delta} MH_2$
	LiH, NaH, KH, RbH, CsH	MgH_2, CaH_2, SrH_2, BaH_2
	MH reacⁿ with water	$BeCl_2 + LiAlH_4 \rightarrow BeH_2 + LiCl + AlCl_3$
	$MH + H_2O \rightarrow MOH + H_2$	$MH_2 + H_2O \rightarrow M(OH)_2 + H_2$
		(CaH_2) → Hydrolith used in production of H_2 gas
		$CaH_2 + H_2O \longrightarrow Ca(OH)_2 + H_2\uparrow$

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3. Thermal Stability

LiH > NaH - - - > CsH BeH > - - - > BaH

Reducing Ch^r $\propto \frac{1}{T.S.}$

LiH < - - - - < CsH BeH < - - - < BaH

4. Reac^n with oxide :

normal oxide : O^{2-} normal oxide : O^{2-}

Li only form normal oxide (Li_2O) Be & Mg → BeO & MgO

Peroxide : O_2^{2-} Peroxide : O_2^{2-}

$Na + O_2 \longrightarrow Na_2O_2$ Ca, Sr, Ba → BaO_2, SrO_2, CaO_2 coloured due to lattice defect

Superoxide : O_2^- ↓ diamagnetic

$M + O_2 \longrightarrow MO_2$

KO_2, RbO_2, CsO_2

- coloured
- Paramagnetic

normal oxide > Peroxide > Superoxide

Basic Ch^r :

$Li_2O < Na_2O < K_2O < Rb_2O < Cs_2O$ BeO < MgO < CaO < SrO < BaO

Ques Which of the following pair is paramagnetic?

(1) KO_2^{-} & $Na_2O_2^{2-}$

(2) BaO_2^{2-} & KO_2^{-}

(3) BaO_2^{2-} & Li_2O^{2-}

(4) ✓ KO_2^{-} & NO_2

Hydroxide :

$M_2O + H_2O \longrightarrow 2MOH$ $MO + H_2O \longrightarrow M(OH)_2$

LiOH < - - - - < CsOH $Be(OH)_2$ < - - - < $Ba(OH)_2$

$6Li + N_2 \rightarrow 2Li_3N$

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Reaction with water

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

Li → less reactive

Na, K, Rb, Cs → easily reactive, react with an explosion

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

Be → do not react with water

Mg → react with hot water

Ca, Sr, Ba → react with cold water

Nitrides :-

Only Li react with nitrogen to form nitride which on hydrolysis give NH_3

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

All gp 2 elements form M_3N_2 type nitride.

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

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

$Ca_3N_2 + 6H_2O \rightarrow 3Ca(OH)_2 + 2NH_3$

Carbides :-

$Be_2C + 4H_2O \rightarrow 2Be(OH)_2 + CH_4$

$Mg_2C_3 + 4H_2O \rightarrow 2Mg(OH)_2 + C_3H_4$

$CH_3-C\equiv CH$

$CaC_2 + 2H_2O \rightarrow Ca(OH)_2 + HC\equiv CH$

$CaC_2 + N_2 \rightarrow Ca(NCN)_2$

$Ca^{2+}\ [N=C=N]^{2-}$

sp

$BaC_2 + N_2 \rightarrow Ba(CN)_2$

Halide :-

$MOH + HX \rightarrow MX + H_2O$

$M_2O + 2HX \rightarrow 2MX + H_2O$

$M_2CO_3 + 2HX \rightarrow 2MX + H_2CO_3$

$M + HX \rightarrow MX_2 + H_2\uparrow$

M.P.

Stability: Fluoride > Chloride > Bromide > Iodide

order of covalent character: $LiCl > NaCl > KCl > RbCl > CsCl$

$LiF < LiCl < LiBr < LiI$

$BeCl_2 > MgCl_2 > CaCl_2 > SrCl_2 > BaCl_2$

K, Rb & Cs ~~so~~ halides react with more halogens to form polyhalides.

$KI + I_2 \longrightarrow KI_3$ $\quad K^+[I_3]^-$

$CsBr + Br_2 \longrightarrow CsBr_3$ $\quad Cs^+[Br_3]^-$

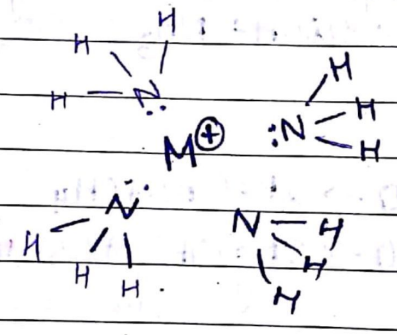
Imp

Reaction with liquid Ammonia :-

All Alkali Metals react with liq. ammonia giving a deep blue color to soln

Ca, Sr, Ba $\xrightarrow{\text{react with liq. } NH_3}$ (Be, Mg) X High I.E.

$$M + (x+y)\,NH_3 \longrightarrow M^+(NH_3)_x + e^{\ominus}(NH_3)_y$$



Characteristic

- These soln are deep blue in color due to ammoniated $e^{\ominus}$ which absorb red color from visible light whose complementary colour is blue.
- conducting in nature
- Reducing in nature

$$O_2 \xrightarrow{e^{\ominus}(NH_3)_y} O_2^- \xrightarrow{e^{\ominus}(NH_3)_y} O_2^{2-}$$

dilute [< 3M] → para
conc^ [> 3M] → dia.

Anamalous behaviour Li :-

R → ~~Same~~ Small size & high +ve charge density
- covalent comp.
- I.E. high & E.N. high
- H.E. ↑
- hard & lightest

Alkali Metal → highly reactive
easily react with air
so kept in kerosene
but Li → in paraffin wax becoz it floats on kerosene.

- Li → M.P. & B.P. highest in group IA
- less reactive.
- form Li_2O normal oxide
- Li_3N while other alkali do not form.

$LiOH \xrightarrow{\Delta} Li_2O + H_2O$
$Li_2CO_3 \xrightarrow{\Delta} Li_2O + CO_2$
$LiNO_3 \xrightarrow{\Delta} Li_2O + NO_2$

other do not decompose
$NaOH \xrightarrow{\Delta} X$
$Na_2CO_3 \xrightarrow{\Delta} X$
$NaNO_3 \xrightarrow{\Delta} NaNO_2 + O_2$

$LiHCO_3$ → liquid
other alkali bicarbonate → solid
~~LiF~~ LiF & Li_2O → less soluble
LiCl → deliquiescent in nature
↑
absorb moisture
$LiCl \cdot 2H_2O$ ←

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Li show diagonal relationship with Mg.

Anamalous behaviour Be

R :- Small size & high +ve charge density
→ Covalent compound.
→ high IE
→ high HE
→ harder than other alkaline earth metals
→ MP & BP highest
→ less reactive
→ dissolve in alkalis & evolve H_2

$Be + 2NaOH \longrightarrow Na_2BeO_2 . 2H_2O + H_2$
Sodium beryllate

→ BeO & $Be(OH)_2$ → Amphoteric in nature

$BeO + H_2SO_4 \rightarrow BeSO_4 + H_2O$
$BeO + NaOH \longrightarrow Na_2BeO_2 + H_2O$
$Be(OH)_2 + HCl \rightarrow BeCl_2 + H_2O$
$Be(OH)_2 + NaOH \rightarrow Na_2BeO_2 + H_2O$

→ form complexes.

Diagonal Relationship :-

Li — Mg
Be — Al
B — Si

→ ~~Small size~~ similiar size or similiar charge / radius ratio.
→ same E.N.

Li and Mg

- Li & Mg → harder
- Li & Mg → react with cold water

Deliquiscent → absorb moisture and changes its state

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Li_2O & MgO] $\xrightarrow{\Delta}$ decompose & form metal oxide
LiOH & $Mg(OH)_2$

- both form nitrides Li_3N & Mg_3N_2

Li_2CO_3 & $MgCO_3$ $\xrightarrow{\Delta}$ Metal oxide + CO_2

LiCl & $MgCl_2$ are dissolve in ethanol.
↓
deliquiscent
$LiCl \cdot 2H_2O$
$MgCl_2 \cdot 8H_2O$

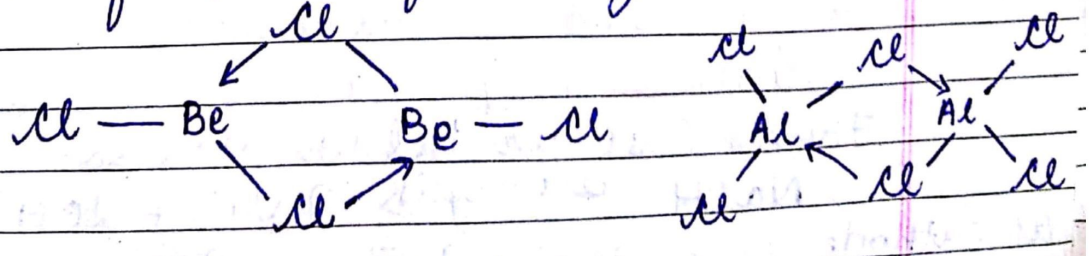
Be & Al

- Same E.N. → 1.5
- not attacked by ~~co~~ acids easily due to formation of oxide layer on their surface

$HNO_3 \rightarrow NO_2 + H_2O + [O]$
$Be + [O] \longrightarrow BeO$
$Al + [O] \longrightarrow Al_2O_3$

$BeCl_2$ & $AlCl_3$

- Bridged chloride structure
- both lewis acid
- used as friedal craft catalyst :



Common ore → Beryl $3BeO.Al_2O_3.6SiO_2$

- Oxides of both are amphoteric

$BeO + HCl \longrightarrow$

$BeO + NaOH \longrightarrow$

$Al_2O_3 + HCl \longrightarrow AlCl_3 + H_2O$

$Al_2O_3 + NaOH \longrightarrow NaAlO_2 + H_2O$

Sodium aluminate

- both Be & Al form complex

$BeF_2 + 2F^- \longrightarrow [BeF_4]^{2-}$

$[Be(C_2O_4)_2]^{2-}$

$Be^{2+} + 4H_2O \longrightarrow [Be(H_2O)_4]^{2+}$

tetrahedral

AlF_6^{3-}

$[Al(C_2O_4)_3]^{3-}$

$[Al(H_2O)_6]^{3+}$

↓

Octahedral

4/09/17

Sodium and its compounds :-

Sodium & Preparation :-

From Castner Kelner process.

$2NaOH \xrightarrow{\text{electrolysis}} 2Na^+ + 2OH^-$

at cathode (Iron) $2Na^+ + 2e^\ominus \longrightarrow 2Na$

at anode (nickel) $4OH^\ominus \longrightarrow 2H_2O + O_2 + 4e^\ominus$

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Note: In castner process, a very little amt. of H_2 is liberated at anode.

From Down's Process :-

$2NaCl \xrightarrow{\text{electrolysis}} 2Na^+ + 2Cl^-$

at cathode (Iron) $2Na^+ + 2e^\ominus \longrightarrow 2Na$

at anode (Graphite) $2Cl^\ominus \longrightarrow Cl_2 + 2e^\ominus$

Compound of Sodium

1. Caustic Soda / NaOH

Prep.: $NaCl \xrightarrow{\text{electrolysis}} Na^+ + Cl^\ominus$

at cathode :- $2Na^+ + 2e^\ominus \longrightarrow 2Na$

$Na + Hg \longrightarrow Na - Hg$

Sodium amalgam

at anode : $2Cl^\ominus \longrightarrow Cl_2 + 2e^\ominus$

$2NaHg + 2H_2O \longrightarrow 2NaOH + 2Hg + H_2$

Note Formⁿ of amalgam is done to lower down the reactivity of Na & rate of reacⁿ is decrease.

Properties of caustic Soda :-

- white solid
- deliquicent in nature.
- $2NaOH + CO_2 \longrightarrow Na_2CO_3 + H_2O$
- Reacⁿ with amphoteric oxide

$Al_2O_3 + NaOH \longrightarrow \overset{+1}{Na}\overset{+3}{Al}O_2^{-4} + H_2O$

Sod. Aluminate

$ZnO + NaOH \longrightarrow Na_2^{+2}Zn^{+2}O_2^{-4} + H_2O$

Sod. Zincate

$SnO + NaOH \longrightarrow Na_2^{+2}Sn^{+2}O_2^{-4} + H_2O$

Sod. stannite

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$SnO_2 + NaOH \longrightarrow Na_2SnO_3 + H_2O$
Sod. stannate

$PbO + NaOH \longrightarrow Na_2PbO_2 + H_2O$
Sod. Plumbite

$PbO_2 + NaOH \longrightarrow Na_2PbO_3 + H_2O$
Sod. Plumbate

Reaction with $ZnCl_2$

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

$Zn(OH)_2 + 2NaOH \rightarrow Na_2[Zn(OH)_4]$
Soluble complex

Uses :-

1. Manufacturing of Sodium
2. in lab.
   $NaOH + CaO \rightarrow$ Soda lime

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

Preparation :- Solvay Process :-

Step-1 formation of ammonium bicarbonate

$NH_3 + H_2O + CO_2 \rightarrow (NH_4)_2CO_3$

$(NH_4)_2CO_3 + H_2O + CO_2 \rightarrow 2NH_4HCO_3$

Step-2 $NH_4HCO_3 + NaCl \longrightarrow NaHCO_3 + NH_4Cl$

Step-3 $2NaHCO_3 \xrightarrow{\Delta} Na_2CO_3 + CO_2 + H_2O$

Step 4 Regeneration of ammonia

$2NH_4Cl + Ca(OH)_2 \longrightarrow CaCl_2 + H_2O + NH_3$

* Limestone is used as raw material in solvay process to obtain CO_2 gas

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

Note. K_2CO_3 cannot be obtained by solvay process because $KHCO_3$ obtained is highly soluble in water.

Properties :-

- white crystalline solid.
- $Na_2CO_3 . 10H_2O \xrightarrow[-9H_2O]{\Delta} Na_2CO_3 . H_2O \xrightarrow{\Delta} Na_2CO_3$
  (A) natron (B) Soda ash

Sodium Bicarbonate / Baking Soda

Prep :- Solvay Process :-

Step-1 $NH_3 + H_2O + CO_2 \longrightarrow (NH_4)_2CO_2$

$(NH_4)_2CO_3 + H_2O + CO_2 \longrightarrow 2NH_4HCO_3$

Step-2 $NH_4HCO_3 + NaCl \longrightarrow NaHCO_3 + NH_4Cl$

Properties :-

- white crystalline solid.
- sparingly soluble in H_2O.
- It is not stored with strong bases like NaOH.

$NaHCO_3 + NaOH \longrightarrow Na_2CO_3 + H_2O$

- On heating it decomposes.

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

Calcium ~~oxide~~ compound :-

Calcium Oxide / Quick lime / CaO :-

Prep. :- $CaCO_3 \xrightarrow{\Delta} CaO + CO_2$

Properties :-

(1) $CaO + H_2O \xrightarrow{\Delta} Ca(OH)_2 + H.E.$ (↗ Heat Energy)

"Slaking of lime".

(2) When CaO is heated oxy-hydrogen flame then white light is produced this is k/n as "lime light".

Calcium cyanamide
$Ca^{2+}[N=C=N]^{2-}$

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(3) $CaO + C \xrightarrow{H^+} CaC_2$

$CaC_2 + H_2O \longrightarrow Ca(OH)_2 + C_2H_2$

$CaC_2 + N_2 \xrightarrow{1000°C} CaCN_2 \xrightarrow{H_2O} NH_3$

Uses :-

(1) (4) Purification of sugar

(2) (5) $CaO + SiO_2 \longrightarrow CaSiO_3$
basic flux acidic impurity Slag

Slaked lime $[Ca(OH)_2]$

Prep. : $CaO + H_2O \longrightarrow Ca(OH)_2 + H.E.$

Properties :-

$Ca(OH)_2 + CO_2 \longrightarrow CaCO_3 + H_2O$
(A) (B)
insoluble (white)

$CaCO_3 + H_2O + CO_2 \longrightarrow Ca(HCO_3)_2$
(B) (C)
soluble

$Ca(HCO_3)_2 \xrightarrow{\Delta} CaCO_3 + H_2O + CO_2$
(C) (B)

Uses :

- used in white wash.
- Prep. of bleaching powder, glass.
- Purification of sugar
- Remove temporary hardness of water.
  Mg^{2+} / Ca^{2+} } Chloride / Sulphate

Calcium Carbonate / $CaCO_3$

Prep. $Ca(OH)_2 + CO_2 \longrightarrow CaCO_3 + H_2$
(limited)

$CaCl_2 + Na_2CO_3 \longrightarrow CaCO_3 + NaCl$

Property :-
1. white
2. insoluble
3. $CaCO_3 \xrightarrow{\Delta} CaO + CO_2$

Uses :-
- in building & construction
- as basic flux
- in toothpaste.

Cement :-

CaO	50 - 60 % max^m AIIMS
SiO_2	20 - 25 %
Al_2O_3	5 - 10 %
MgO	2 - 3 %
Fe_2O_3	1 - 2 %
SO_3	1 - 2 %

SiO_2 : Al_2O_3
2.5 : 1
↓
4 : 1

CaO : other oxides (SiO_2, Al_2O_3, Fe_2O_3)
2 : 1

Portland Cement :-

$CaO\ (61.5\%) + SiO_2\ (22.5\%) + Al_2O_3\ (7.5\%) + MgO\ (2.5\%)$

Imp. ~~Indus~~ Ingredients of Portland cement :-

Dicalcium Silicate	$2CaO.SiO_2$
Tricalcium Silicate	$3CaO.SiO_2$
Tricalcium aluminate	$3CaO.Al_2O_3$

tetracalcium aluminate ferrite $4CaO.Al_2O_3.Fe_2O_3$

Gypsum ($CaSO_4.2H_2O$) is added in cement to slowdown setting of cement.

$CaSO_4.2H_2O \xrightarrow{\Delta} CaSO_4.\frac{1}{2}H_2O \xrightarrow{\Delta} CaSO_4$

Gypsum — POP — dead burnt Plaster

Compound of Na :-

1. Washing Soda
2. Natron
3. Baking Soda
4. Caustic Soda
5. Glauber's Salt — $Na_2SO_4.10H_2O$
* 6. Trona — $Na_2CO_3.2NaHCO_3.3H_2O$
* 7. Sodium Thiosulphate or Hypo — $Na_2S_2O_3.5H_2O$
8. Borax / Tincal / Suhaga — $Na_2B_4O_7.10H_2O$
9. Microcosmic Salt — $NaNH_4HPO_4.4H_2O$
* 10. Cryolite — Na_3AlF_6
11. Chile Salt Petre — $NaNO_3$

Compound of K :-

* 1. Indian Salt Petre — KNO_3
* 2. Carnellite — $KCl.MgCl_2.6H_2O$
* 3. Nesseler's Reagent — $K_2HgI_4 + KOH$
4. Sylvine — KCl

Compound of Ca :-

1. Quick lime
2. Slaked lime
3. Gypsum
4. P.O.P.
5. Limestone / Chalk / Marble — $CaCO_3$
6. Bone / Phosphorite — $Ca_3(PO_4)_2$
* 7. Nitrolium — $CaCN_2 + C$

Compound of Mg :-

1. Magnesia — MgO
* 2. Milk of Magnesia (to neutralise acidity) — $Mg(OH)_2$
* 3. Magnesite — $MgCO_3$
* 4. Dolomite
* 5. Sorrel's cement — $MgSO_4 \cdot 7H_2O$
or — $MgCl_2 : 5MgO \cdot xH_2O$ used in dental filling
*. Magnesia Cement

Biological Importance :-

1. KO_2 is used in space capsules & submarine becoz it removes CO_2 and gives O_2

$$KO_2 + CO_2 \longrightarrow K_2CO_3 + O_2$$

2. $CaCl_2$ is used as drying agent becoz it is hygroscopic in nature.
3. Anhydron $Mg(ClO_4)_2$ is used as dehydration agent. ↓ magnesium Perchlorate
4. Elektron Alloy 95% Mg + 5% Zn used in making aircraft bodies.

- Na & K controls Blood Pressure of human body.
- A 70 kg man
  90 g Na & 170 g K
  5 g Fe & 0.06 g Ca.
- Ca → 1200 g
  Mg → 25 g } in body.
- $(COOH)_2 + Ca(OH)_2 \rightarrow Ca(C_2O_4)$
  $Ca(C_2O_4)$ → responsible for kidney stone.