Inorganic chemistry

IMP. RXNS / Short Notes

Ch-1 S-Block

GP. - 1 (alkali metals)

- Halides
- Hydride
- Hydroxide
- Reducing Nature
- Sol^n in Liq. NH_3
- Oxides / Peroxide / Superoxide
- Solubility
- Density
- M.P. & B.P
- I.E.
- Colour on Bunsen burner

- $-\Delta H_f$ of florides decrease down the gp. while for chlorides Bromine & Iodides increase down the group.
- All Halides - soluble in H_2O - except:
  - LiF & CsI
  - LiF ($\uparrow$ L.E.)
  - CsI ($\downarrow$ H.E.)
- M.P & B.P order
  - Flouride > Chloride > bromide > Iodide
- LiI - Soluble in Pyridine also.

- LiH — covalent
- NaH ↕ Ionic (Fajans rule)
- CsH
- MOH
- T.S. ↑
- only LiOH Thermally unstable.
- $LiOH \rightarrow Li_2O + H_2O$
- T.S. ↓
- (No polymeric Hydrides)

- M.P & BP → ↓ ↓ (regular trend)
- Strong reducing agent
- Li > Cs > Rb > K > Na

When metal (gp-1 & II) dissolve in liq NH_3 (conc. < 3M) it form deep blue colour solution which is paramagnetic & highly conducting due to the of Ammoniated cation and ammoniated electron.

$M + (x+y)NH_3 \rightarrow \underset{\text{(cation)}}{[M(NH_3)_x]^+} + \underset{\text{(ammonited e}^-\text{)}}{[e(NH_3)_y]^-}$

- * Blue colour sol^n becomes lighter & disappear after some time & become bronze (diamagnetic) and form metal ammide
- Lattice energy is dominant (K ↑ Solubility)
- LE ↓ Solubility ↑ except $Br^-, I^-, ClO_4^-, NO_3^-$] decrease

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- Density ↑ but Na is more denser than K (due to large size diff.)

- Hyarat & Ionisat Energy ↓ down the gp.
- Li — most Hydrated ($LiCl \cdot 2H_2O$)
- Mobility ↑
- Conductivity ↑
- No ethynide ion with ethyne
- LiF & Li_2O + less Soluble in H_2O

- It shows diagonal relat^n ship with Mg. (due to similarity in ionic size and q/m ratio)
- both $LiCl$ & $MgCl_2$ — deliquesant

Rxn with air (O_2)

- Li → oxide + some peroxide
- Na = Peroxide + some superox. (O_2^{-2})
- K, Rb, Cs = Superoxide (O_2^-)

absorb CO_2 & release O_2 in aircraft, submarine, spaceship (Purificat^n of air)

⇒ oxide > Peroxide > Superoxide] stability (bcz of L.E.)

- Oxide — Colourless (Paired e$^-$ wt)
- Peroxide — oxidising agent
- Superoxide — Para-magnetic

- Li = Crimson red
- Na = Yellow
- K = Violet
- Rb = Red violet
- Cs = Blue.

- Carbonate
  - only Li_2CO_3 decompose on Heating
  - $Li_2CO_3 \xrightarrow{\Delta} Li_2O + CO_2$
  - Na_2CO_3 to $Cs_2CO_3 \xrightarrow{\Delta} X$

- Bicarbonates
  - only $LiHCO_3$ exist in aq. state (High H.E.)

- Nitride (N^{-3})
  - only Li form nitride)

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except Li: $Li \xrightarrow[air]{} \text{oxide} + \text{nitride} \xrightarrow{H_2O}$ Hydroxide + NH_3

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* Diagonal Prop. of Li.

- Nitrate (NO_3^-) ($\downarrow$ T.S. ↑)
  - other: $(MNO_3) \xrightarrow{\Delta} MNO_2 + \frac{1}{2}O_2$
  - Lithium: $(LiNO_3) \xrightarrow{\Delta}$ oxide + $NO_2 + \frac{1}{2}O_2$

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Compounds of 5p I

NaCl — Down cell electrolysis in the presence of $CaCl_2 + KF$ ($\downarrow$ M.P. of NaCl) → (Na) at cathode → Na_2O_2 → Na_2SO_4 + H_2O_2 ★ (Merck Process)

⇒ Crude Sodium chloride obtained by crystallizat^n of (aq. NaOH, Na_2SO_4, $CaSO_4$, $CaCl_2$ & $MgCl_2$)

⇒ $CaCl_2$ & $MgCl$ = impurities bcz they are deliquescent.

NaOH (caustic soda) — Castner-Kellner cell → electrolysis of NaCl in presence of Hg cathode and carbon anode → Na/Hg (sodium amalgam) (at cathode) $\xrightarrow{H_2O}$ $NaOH_{(aq.sol.)}$ + H_2 ★ + 2Hg

$NaOH_{(aq.sol.)}$ → Translucent solid = deliquescent

= At anode $Cl^- \longrightarrow \frac{1}{2}Cl_2$ ★ $+ e^-$

↳ by product.

- Used in purificat^n of bauxite & Petroleum refining.

$Na_2CO_3 \cdot 10H_2O$ (Washing soda) — Solvay Process

$NaCl$ + Brine sol^n + $NH_3 + CO_2 + H_2O$ → $NaHCO_3$ (crystals) $\xrightarrow{\Delta}$ $Na_2CO_3 + CO_2 + H_2O$

$Na_2CO_3 \xrightarrow{10H_2O} Na_2CO_3 \cdot 10H_2O$

- NH_3 is recovered when sol^n containing NH_4Cl is treated with $Ca(OH)_2$

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

- Solvays Process is not used to prepare $KHCO_3$ bcz it is very soluble to be precipitated.

- $Na_2CO_3 \cdot 10H_2O \xrightarrow{375\,K} Na_2CO_3 \cdot H_2O + 9H_2O$ (monohydrate)

$\xrightarrow{>375\,K} Na_2CO_3 + 10H_2O$

= White power = Soda ash.

= ~~Monohydrate~~

$NaHCO_3$ (Baking Soda)

$Na_2CO_3 + H_2O + CO_2 \longrightarrow NaHCO_3$

decompe on heating to generate bubble of CO_2 (∴ holes in cakes & make them light & fluffy)

⇒ It is mild antiseptic for skin infect^n

= Used in fire extinguishers.

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Be, Mg, Ca, Sr, Ba

Oxide | Peroxide

Metal $\xrightarrow{air}$ oxide + nitride (M_3N_2)

↓ H_2O

Hydroxide

↓ T.S. ↑

Hydroxide + NH_3

↓ CO_2

HCO_3^{-2} & $NHCO_3$

Be & Mg - kinetically inert to oxygen & water (due to formation of an oxide film)

$M + X_2 \rightarrow MX_2$ (F → I)

- Thermal decomposition of $(NH_4)_2BeF_4$ is best route for prep. of BeF_2.
- $BeO + C + Cl_2 \rightleftharpoons BeCl_2 + CO$ (Δ)
- Str. of $BeCl_2$ (in solid) — Polymeric

Be: sp^3 → $\xrightarrow{\Delta}$ (≤1200 K) → Be: sp^2

$BeCl_2$ (in vapour) → (>1200 K) → Be: Sp

MH_2 type Hydride

- BeH_2 & MgH_2 — covalent & polymeric Hydride

Be: sp^2 (non-planar) — 3 C-2e⁻ bond

- BeH_2 prep. by rxn of $BeCl_2$ with $LiAlH_4$

$2BeCl_2 + LiAlH_4 \rightarrow 2BeH_2 + LiCl + AlCl_3$

- Oxide & other comp. of Be & Mg are more covalent than other elements.

BeO — rock salt str.

ΔH_f of oxides ↑

except BeO (amphoteric) are oxides of ion.

= All oxides are basic in nature.

= T.S ↑ Basic nature ↑ (For Hydroxide)

$Be(OH)_2 + OH^- \rightarrow [Be(OH)_4]^{-2}$ (Beryllate ion)

Gp. II (alk. earth metal (except - Be))

Rxn with air and water

Halides

Carbonate, $MHCO_3$

Nitrate

Sulphate

Density

Solubility

Hydride

Flame test

Be, Mg] No flame (High IE) test

Ca - Brick red

Sr - Crimson red

Ba - Apple green

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

↓ T.S. ↑

$Ba(NO_3)_2$

- $Mg(NO_3)_2$ — crystallises with six molecules of water
- $Ba(NO_3)_2$ → crystalises as anhydrous salt.

⇒ All element form nitrite. (Be_3N_2, Mg_3N_2)

MCO_3 type: on heating all carbonate is decompose

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

↳ stored in atm. of CO_2.

↓ T.S ↑ solubility ↓

- All bicarbonate exist in aq. state.
- Carbonates — insoluble in H_2O

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

White solid and stable to heat.

solubility ↓ (BeSO₄ & MgSO₄ - readily soluble in water ↑ ΔHE.)

B.P. ⇒ Be > Ba > Ra > Ca > Sr > Mg

M.P. = Be > Ca > Sr > Ba > Mg

Ca > Mg > Be > Sr > Ba

का मा बे सर बहादुर (E)

Hydration energy is dominant ∝ (∝ solubility)

= Hydration ↓ = solubility ↓

except (F^-, O^{-2}, OH^-) → ↑ down the gp.

$BeF_2 > BaF_2 > SrF_2 > CaF_2 > MgF_2$

(High IE)

- $HE_{II} > HE_I$
- No element show Photoelectric effect (High IE)
- only Be, Mg - form complex comp.
- All enzyme that utilise ATP in phosphate transfer req. magnesium as cofactor.

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$CaCO_3$ $\underset{\Delta \text{ kiln}}{\overset{\text{in rotatory}}{\rightleftharpoons}}$ $CaO + CO_2 \xrightarrow{H_2O} Ca(OH)_2$

Limestone (Insoluble)

(White amorphous solide)
absorb moisture & CO_2.
(basic oxide)
= used as flux

Slaked lime
= less soluble in H_2O
(Amorphous powder)
= Used in prep. of mortain.
White tanning industry.

- In cement
- Artifcat of sugar.

SiO_2 → $CaSiO_3$

P_4O_5 → $Ca_3(PO_4)_2$ (Thomas slag)

$Ca(OH)_2 + Cl_2$ → $CaCl_2 + Ca(OCl)_2 + 2H_2O$
(Bleaching powder)

OCl^- – Active component of bleching powder.

* $CaCO_3$ & $MgCO_3$ = Used as flux in extrat^n of metals (eg. Fe)
* $CaOCl_2 \xrightarrow{H_2O} Ca^{+2} + Cl^- + OCl^-$

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199. sol.

(Milk of Lime) (Suspension)

(Lime water)

CO_2 → $CaSO_3$

CO_2 → $CaCO_3$ (Milky colour)

CO_2 (excess) → $Ca(HCO_3)_2$ (colourless) (water soluble)

$CaSO_4 \cdot \frac{1}{2}H_2O$ (POP) : Hemihydrate of Calcium Sulphate

$CaSO_4 \cdot 2H_2O \xrightarrow{<393K} CaSO_4 \cdot \frac{1}{2}H_2O \xrightarrow{>393} CaSO_4$ (anhydrous)
(gypsum) (POP) = 'dead burnt Plaster'

* Setting ($+H_2O$) ⇒ 5 to 15 min. (Hard Solid mass)

* **Cement** : d. by Joseph Aspdin ⇒ Portland cement.

For Good cement :

$\frac{SiO_2}{Al_2O_3}$ - 2.5 to 4 ; $\frac{CaO}{Al_2O_3 + SiO_2 + Fe_2O_3}$ = 2

CaO = 50-60 %.	MgO = 2-3 %.	* Limestone + Clay → cement clinker
SiO_2 = 20-25 %	Fe_2O_3 = 1-2 %.	
Al_2O_3 = 5-10 %.	SO_3 = 1-2 %.	2-3 %. (w/w) gypsum → ↓. cement.

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