TOPICS TO BE COVERED

1. Complete NCERT

S-Block

$Be(OH)_2$: Amphoteric
BeO

Top ↓ Bottom

Size ↑

Ionisation Energy ↓

Electronic Configuration

Li	$[He]\,2s^1$	Be	$[IG]\,ns^2$
Na	$[Ne]\,3s^1$	Mg	
K	$[Ar]\,4s^1$	Ca	$[Ar]\,4s^2$
Rb	$[Kr]\,5s^1$	Sr	
Cs	$[Xe]\,6s^1$	Ba	
Fr	$[Rn]\,7s^1$	Ra	

$[IG]\,ns^1$

$M.C \propto \frac{1}{I.E.}$

$I.E._1$ K < Ca

$I.E._2$ K > Ca

Metallic character ↑ $(M \longrightarrow M^+ + e^-)$

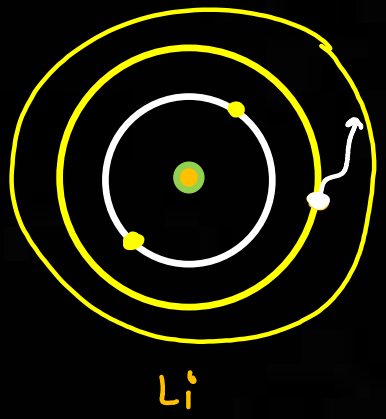
Photoelectric Effect K | Rb | Cs

Oxidation state G-1 : +1 | G-2 : -2

Radio-active Fr | Ra

Flame Test

Colour : Transition



Rv = Rb

Sea is blue.

Li	Crimson Red
Na	Yellow
K	Violet
Rb	Red Violet
Cs	Blue

Be, Mg → No Colour

CaR CaB

Ca	Brick Red
Sr Li	Crimson Red
Ba	Apple Green

Baaq is green.

NCERT

The electrons in **Be and Mg** are too strongly bound to get excited by flame. Hence, these elements do not impart any colour to the flame.

Metallic Bonding

Electron Sea Model

No. of free Electrons ↑

Metallic Bonding ↑

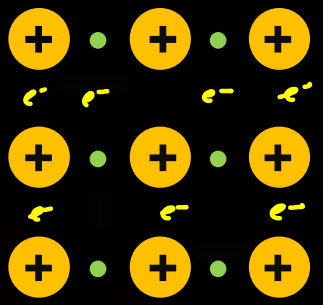
Group I $\rightarrow Na^{+} + e^{-}$ < Group II $\rightarrow Ca^{2+} + 2e^{-}$

Harder

Melting point ↑

Boiling point ↑

Soft ↓



Metals have high Electrical and Thermal conductivity.

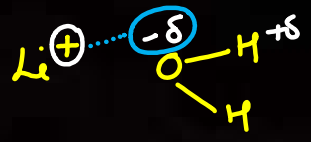
Metals are Silvery White, Soft & Light. Be / Mg → Greyish

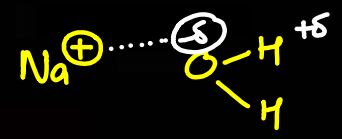
Hydration Energy

$Na^+_{(g)} + H_2O \longrightarrow Na^+_{(aq.)} + H.E.$

Amount of energy released when one mole of ions undergoes hydration

Charge Density : $Li^{\oplus} > Na^{\oplus}$





Radius $_{(g)}$: $Li^+ < Na^+$

Radius $_{(aq)}$: $Li^+ > Na^+$

Ion Dipole Interaction : $Li^+ \gg Na^+$

Hydration Energy : $Li^+ > Na^+$

Mobility : $Li^+_{(aq.)} < Na^+_{(aq.)}$

HE : $Li^+ \ll Be^{2+}$

Water of Crystallisation

$NaCl \cdot xH_2O$ ✗

NCERT

Li^+ has maximum degree of hydration, so its salts are mostly hydrated.

$LiCl.\ 2H_2O$ → WOC = 2

Mg^{2+} Ca^{2+}

$MgCl_2$ and $CaCl_2$ exist as $MgCl_2.6H_2O$ and $CaCl_2.\ 6H_2O$ while NaCl and KCl do not form such hydrates.

Solubility in water

→ (H.E.) ↑↑ (L.E.) ↓

$NaCl_{(s)} \xrightarrow{L.E.} Na^+_{(g)} + Cl^-_{(g)} \xrightarrow{H_2O} Na^+_{(aq.)} + Cl^-_{(aq.)}$

$(H.E.)_{Cl^-}$

$(H.E.)_{Na^+}$

Extent of Solubility ∝ | L.E. – H.E. |

Solubility in Water

Solubility ↓↓

Perfect lattice : $R_- \approx R_+$

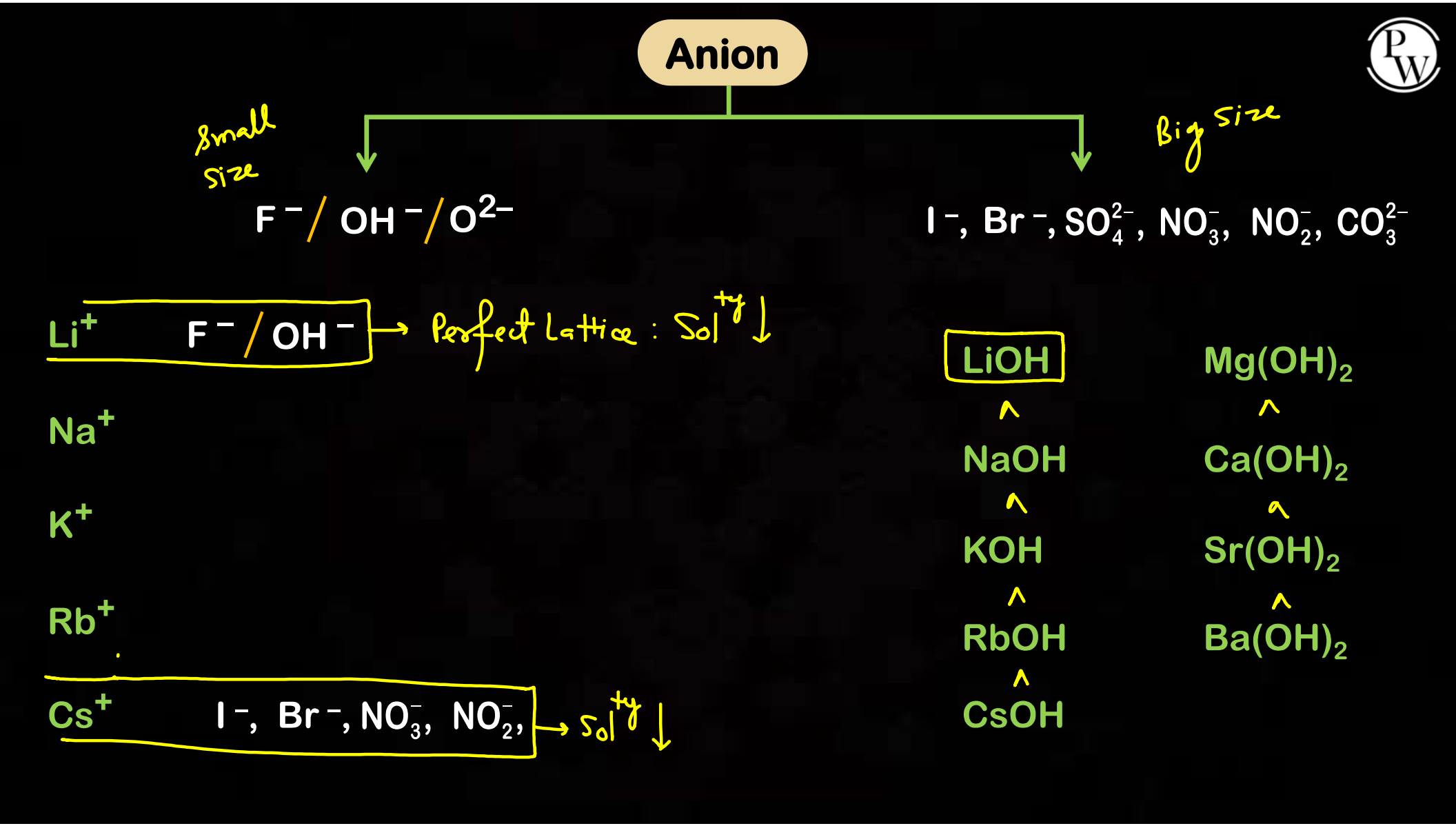
Solubility ↑↑

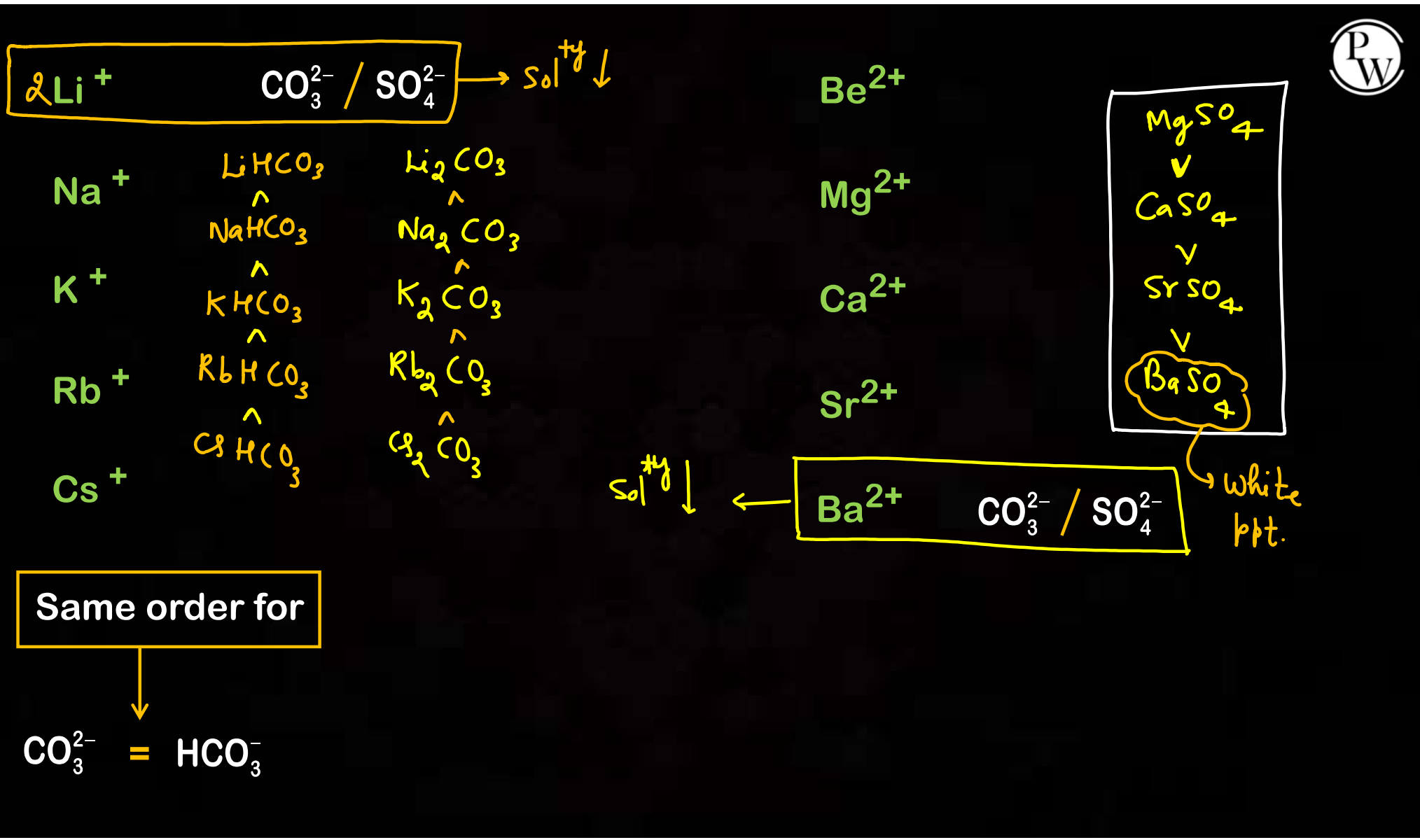
Imperfect lattice : $R_- > R_+$

Extent of Solubility $\propto |R_- - R_+|$

LiF < CsF

Size : $Li^+ < Cs^+$


Anion
Small size
Big size
F^- / OH^- / O^{2-}
I^-, Br^-, SO_4^{2-}, NO_3^-, NO_2^-, CO_3^{2-}
Li^+ F^- / OH^- → Perfect Lattice : Sol^{ty} ↓
Na^+
K^+
Rb^+
Cs^+ I^-, Br^-, NO_3^-, NO_2^-, → Sol^{ty} ↓
LiOH
NaOH
KOH
RbOH
CsOH
$Mg(OH)_2$
$Ca(OH)_2$
$Sr(OH)_2$
$Ba(OH)_2$


Li+ CO3 2− / SO4 2− → Sol^ty ↓
Na+
K+
Rb+
Cs+
LiHCO3
NaHCO3
KHCO3
RbHCO3
CsHCO3
Li2CO3
Na2CO3
K2CO3
Rb2CO3
Cs2CO3
Be2+
Mg2+
Ca2+
Sr2+
Ba2+ CO3 2− / SO4 2− → Sol^ty ↓
MgSO4
CaSO4
SrSO4
BaSO4
white ppt.
Same order for
CO3 2− = HCO3−

Reaction with O_2

$O_2 \rightarrow O_2^- \rightarrow O_2^{2-} \rightarrow O^{2-}$

O_2^- : Superoxide

O_2^{2-} : peroxide

oxide : O^{2-}

Li → oxide → Li_2O

Na → peroxide → Na_2O_2

K, Rb, Cs → Superoxide → KO_2, RbO_2, CsO_2

Be, Mg, Ca → MgO

Be → BeO → Amphoteric (HCl / $NaOH$)

Ca → CaO

Sr, Ba → SrO_2, BaO_2

$O_2^- \rightarrow O_2^-$

Reaction with H_2O

Oxides

$Mg^{2+}\ O^{2-}$

$MgO \xrightarrow[H^+ / \bar{O}H]{H_2O} Mg(OH)_2$

Peroxides

$2Na^+\ O_2^{2-}$

$Na_2O_2 \xrightarrow[\bar{O}H]{H_2O,\ H^+} H_2O_2 + 2NaOH$

Superoxides

$KO_2 \xrightarrow[H^+ / \bar{O}H]{H_2O} O_2\uparrow + H_2O_2$

KOH

K^+ + O_2^- → O_2^{2-} + O_2

Oxide & Hydroxide of Be

Be^{2+} $O^{2-}/F^-/Cl^-/Br^-/I^-$

Essentially covalent in nature

BeO

$Be(OH)_2$ → Amphoteric Nature

H O — Be — OH

$Be(OH)_2 + 2NaOH \longrightarrow Na_2[Be(OH)_4]$

$2\bar{O}H$

$Na_2BeO_2 \cdot 2H_2O$

$2\bar{O}H \quad 2H^+ \; 2Cl^-$

$Be(OH)_2 + 2HCl + 2H_2O$

$[Be(H_2O)_4]^{2+} \; 2Cl^-$

$[Be(H_2O)_4]Cl_2$

Halides

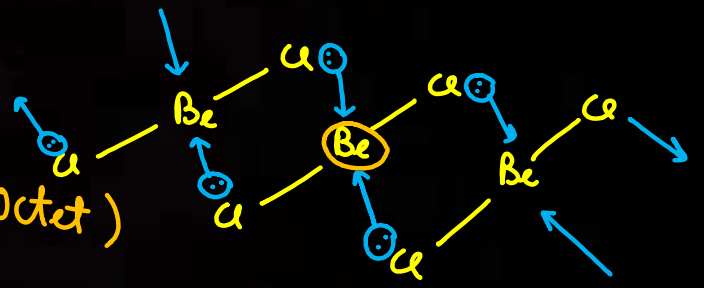
Be^{2+} $I^{\ominus}$

$BeF_2 < BeCl_2 < BeBr_2 < BeI_2$: Covalent

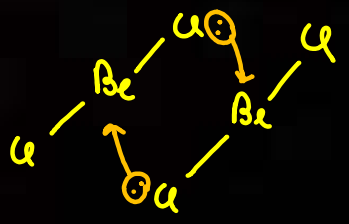
Beryllium halides are essentially covalent and soluble in oganic solvents.

Polymer.

$BeCl_2$ (Solid) → Be (Octet)



$BeCl_2$ (vapour phase)



$BeCl_2$ (High temp.) Cl — Be — Cl

Ionic

$MgCl_2$

$CaCl_2$

All other halides of alkaline earth metals are ionic in nature except Be.

Reaction with H_2

Nitride : N^{3-}

Li, Na, K, Rb, Cs: $2Na + H_2 \rightarrow 2Na^+ + 2e^-$, $2H^-$

$H_2 + 2(MH) \rightarrow M^+ H^-$ (Ionic crystals)

Be: $Be + H_2 \not\rightarrow$

Mg, Ca, Sr, Ba: $M + H_2 \rightarrow MH_2$

$LiAlH_4$

$LiH \quad AlH_3$

$Li^+ H^-$

Reaction with N_2

Li, Na, K, Rb, Cs: $N_2 \not\rightarrow$

$Li + N_2 \rightarrow Li_3N$

Be, Mg, Ca, Sr, Ba: $M + N_2 \rightarrow M_3N_2$

NCERT

BeH_2 can be prepared by the reaction of $BeCl_2$ with $LiAlH_4$.

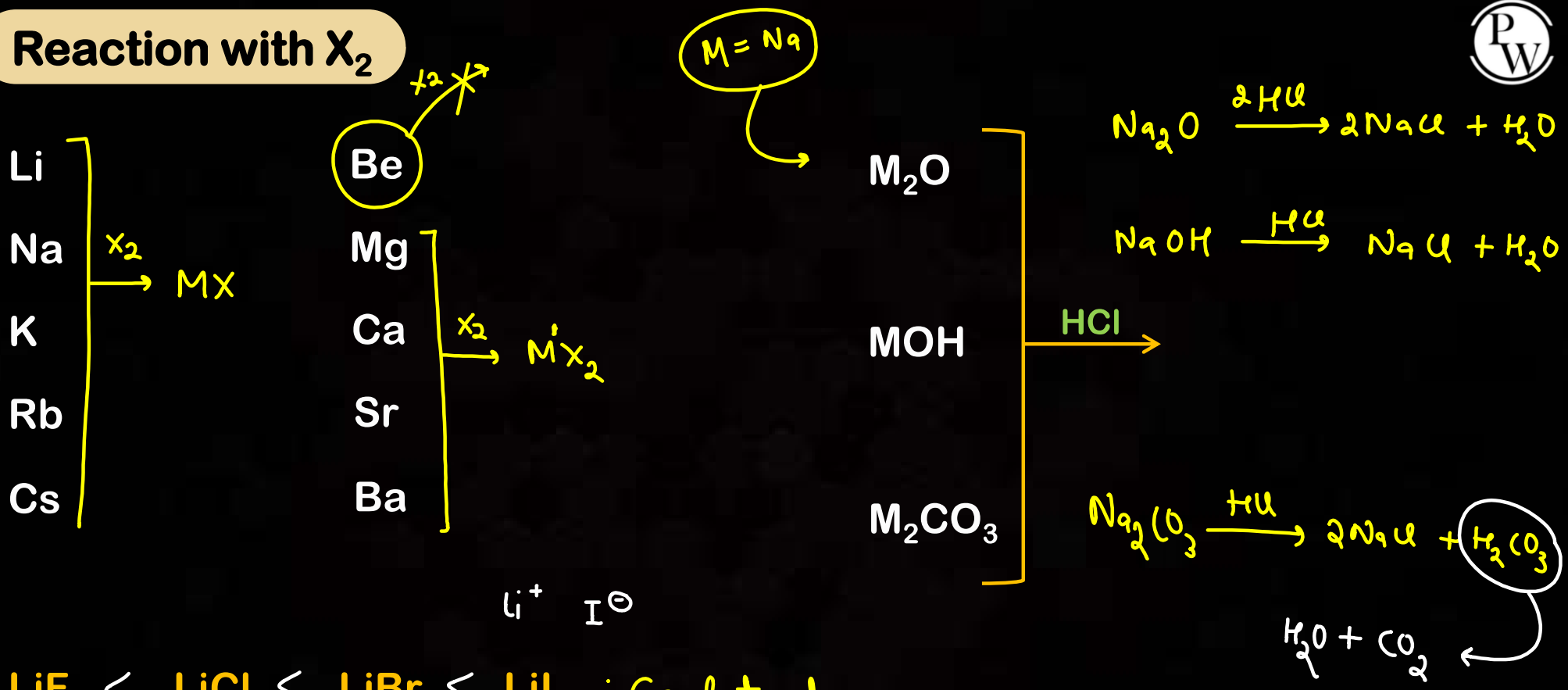
$Cl - Be - Cl \xrightarrow[\text{Ether}]{LiAlH_4} BeH_2 + AlCl_3 + LiCl$

Reaction with H_2O

$Li_3N \xrightarrow[H^+ / \bar{O}H]{H_2O} LiOH + NH_3\uparrow$

$3Li^+ \quad N^{3-}$

Reaction with X_2



LiF < LiCl < LiBr < LiI : Covalent nature

Lithium halides are somewhat covalent. It is becasue of the high polarisation capability of lithium ion.

NCERT

Formation of BeF_2

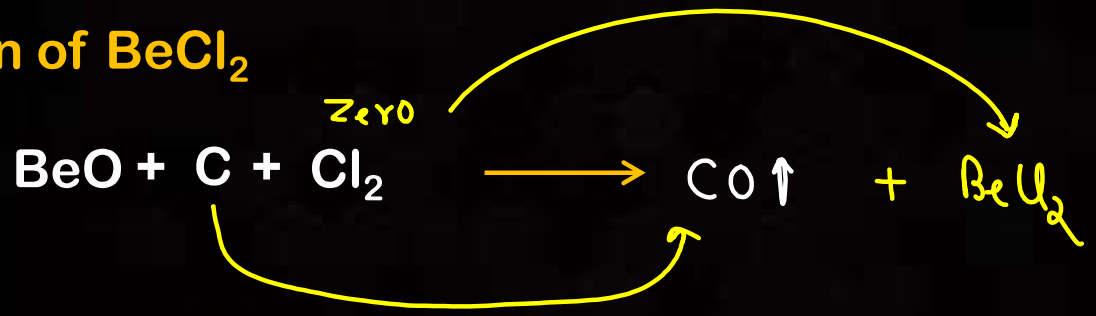
$BeF_2 + 2F^- \longrightarrow [BeF_4]^{2-}$

Ammonium-tetrafluoroberylate $\xrightarrow{\Delta}$ $BeF_2 + 2HF + 2NH_3\uparrow$

$2NH_4^+ \cdot [BeF_4]^{2-}$

$2\left(NH_4^+ = \ddot{N}H_3 + H^+\right)$ $\quad BeF_2 + 2F^-$

Formation of $BeCl_2$



Reaction with water

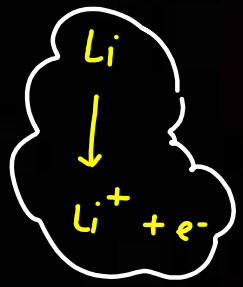
Li — E°_{RP} = Most negative

Na

K

Rb

Cs



Be

Mg

Hot water

Ca

Sr

Ba

Li : Covered with Wax

Na to Cs : Kerosine

Density

Li ↓

$d = \frac{m}{v}$

$d \propto m$

Li

^

Na

v

K

^

Rb

^

Cs

Soft nature ↑

Top

Bottom

NCERT

Metal in $NH_{3(\ell)}$

Li

Na

K Ca

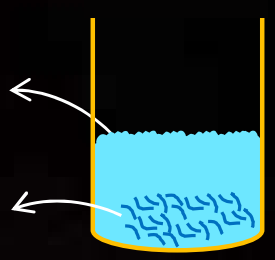
Rb Sr

Cs Ba

$Na_{(g)} + H_2O \longrightarrow Na^+_{(aq.)}$

$Na^{\oplus} + \ddot{N}H_3 \hookrightarrow Na^+$

$NH_{3(\ell)}$



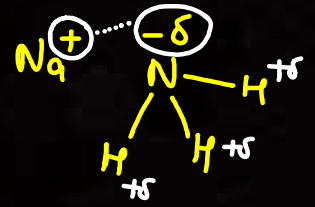
Metal

Blue Solution

$Na \longrightarrow Na^+ + e^-$ (in NH_3)

$[e(NH_3)_y]^-$: Ammoniated Electron

Na^+ (in NH_3) $\rightarrow [Na(NH_3)_x]^+$



Ammoniated electron

Conductivity

Paramagnetic

Blue in colour

Reducing nature

Concentration of solution : Blue $\longrightarrow$ Bronze

: Paramagnetic character $\downarrow$

Reducing Character

$Li_{(s)} \longrightarrow Li^+_{(aq.)} + e^-$

Li : $E^\circ_{Li^+/Li}$ = Most negative

ज्यादातर RA : $Li \longrightarrow Li^+ + e^-$

$M_{(s)} \xrightarrow{AE} M_{(g)}$

$M_{(g)} \xrightarrow{I.E.} M^+_{(g)} + e^-$

$M^+_{(g)} + H_2O \xrightarrow{H.E.\uparrow} M^+_{(aq)}$

Investment ← Atomization enthalpy, Ionisation enthalpy

Profit. ← Hydration enthalpy

$M_{(s)} \longrightarrow M^+_{(aq)} + e^-$

E°_{RP} = Most negative.

(H.E. ↑↑ | AE ↓ | I.E ↓)

Reducing Character

Most negative RP of Li : RA ↑↑

Li	– 3.04
Na	– 2.714
K	– 2.925
Rb	– 2.930
Cs	– 2.927

$Li \longrightarrow Li^+ + e^-$

E° = Less negative

Be	– 1.97
Mg	– 2.36
Ca	– 2.84
Sr	– 2.89
Rb	– 2.92

$Be \longrightarrow Be^{2+} + 2e^-$

H.E. ↑

A.E. ↑↑

With the small size of its ion, lithium has the **highest hydration enthalpy** which accounts for its high negative E_0 value and its high reducing power.

Reducing nature of Beryllium is due to large hydration energy associated with the small size of Be^{2+} ion and **relatively large value of the atomization enthalpy** of the metal.

Thermal Stability

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

Thermal Decomposition

$Na_2CO_3 \xrightarrow{\Delta}$ ✗

Thermally Stable

$r_+ \downarrow\downarrow$: L.E. ↑

$L.E. \propto \frac{1}{r}$

Thermally Stable : Strong lattice → L.E. ↑↑

→ Ionic Character ↑↑

$r_+ \downarrow\downarrow$: Covalent character ↑

: Ionic character ↓

Anions

Mono atomic anions

F^- Cl^- Br^- I^- O^{2-}

Lattice Energy

T.S. $\propto$ L.E.

Poly atomic anions

T.S $\propto$ I.C

SO_4^{2-}, NO_3^-, NO_2^-, CO_3^{2-}

Ionic character

Li^+ LiCl

Na^+ NaCl

K^+ KCl

Rb^+ RbCl

CsCl

$\gamma_+ \uparrow$: L.E. $\downarrow$

Thermal Stability $\downarrow\downarrow$

$\gamma_+ \uparrow\uparrow$

I.C. $\downarrow$

T.S. $\downarrow$

Li_2SO_4

Na_2SO_4

K_2SO_4

Rb_2SO_4

Cs_2SO_4

Lattice Energy

O^{2-}

BeO

MgO

CaO

SrO

BaO

T.S. $\propto$ L.E.

$\gamma_+ \uparrow\uparrow$

L.E. $\downarrow\downarrow$

T.S. $\downarrow$

Ionic character

CO_3^{2-}

Poly atomic

T.S. $\propto$ I.C.

$BeCO_3$

$MgCO_3$

$CaCO_3$

$SrCO_3$

$BaCO_3$

$\gamma_+ \uparrow\uparrow$

I.C. $\downarrow$

T.S. $\downarrow$

Heating Effect

Metal Carbonates

CO_3^{2-}

Metal Carbonate $\xrightarrow{\Delta}$ Metal oxide + $CO_2\uparrow$

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

$Na_2CO_3 \xrightarrow{\Delta}$ ✗

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

M = Li & Be to Ba

M ≠ Na / K / Rb / Cs

Carbonates → Thermally Stable

Metal Sulphate

SO_4^{2-}

Metal Sulphate $\xrightarrow{\Delta}$ Metal oxide + SO_3 $\xrightarrow{800^\circ C}$ $SO_2\uparrow + \frac{1}{2}O_2\uparrow$

$CaSO_4 \xrightarrow{\Delta} CaO + SO_3\uparrow$

$Li_2SO_4 \xrightarrow{\Delta} Li_2O + SO_3\uparrow$

M = Li , Mg , Ca

M ≠ Na / K / Rb / Cs

Metal bi-carbonate

HCO_3^-

Metal bicarbonate $\xrightarrow[(Aq.)]{\Delta}$ Metal Carbonate + H_2O + $CO_2\uparrow$

Aq. Sol^n. ✓ Solid ✗

M = Li & Be to Ba

M = Na / K / Rb / Cs

Exist in solid phase

Na | K
Rb | Cs

$MHCO_{3\,(s)} \xrightarrow{\Delta} M_2CO_3 + H_2O + CO_2\uparrow$

$2\,LiHCO_3 \xrightarrow{boil} Li_2CO_3 + H_2O + CO_2\uparrow$

$2NaHCO_{3\,(s)} \xrightarrow{\Delta} Na_2CO_3 + H_2O + CO_2\uparrow$

Metal Nitrates → NO_3^-

Metal Nitrate $\xrightarrow{\Delta}$ Metal oxide + NO_2 + O_2 M = Li & Be to Ba

Metal Nitrate $\xrightarrow{\Delta}$ Metal Nitrite + $O_2\uparrow$ M = Na , K , Rb , Cs

$2\,LiNO_3 \xrightarrow{\Delta} Li_2O + NO_2\uparrow + O_2\uparrow$

$NaNO_3 \xrightarrow{\Delta} NaNO_2 + O_2\uparrow$

$Mg(NO_3)_2 \xrightarrow{\Delta} MgO + NO_2\uparrow + O_2\uparrow$

Some Important compounds of Sodium

Caustic Soda

$NaOH$

Baking Soda

$NaHCO_3$

Sod. (bi) Carbocatus

Washing Soda

$Na_2CO_3 \cdot 10H_2O$

Reaction with $NaOH_{(aq)}$:

$B(OH)_3$ — $NaOH$ (base)

Acids :

$H_3BO_3 \xrightarrow[Na^+\ \bar{O}H]{NaOH} Na\,[B(OH)_4] \equiv NaBO_2 \cdot 2H_2O$

$H^+\ NO_3^-$ ← $HNO_3 \xrightarrow[Na^+\ \bar{O}H]{NaOH} NaNO_3$

$3H^+\ PO_4^{3-}$ ← $H_3PO_4 \xrightarrow{NaOH} Na_3PO_4$

Oxides :

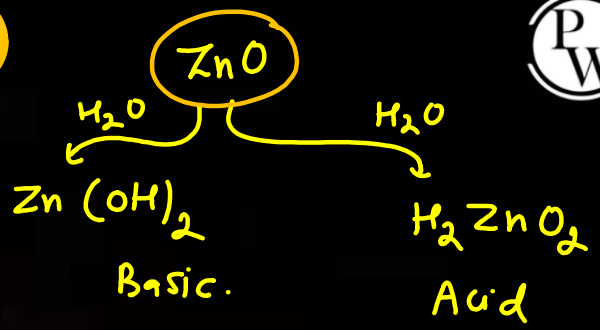
$B_2O_3 \xrightarrow{NaOH\,(aq.)} NaBO_2 \cdot 2H_2O$

H_3BO_3 ← $+5$ $N_2O_5 \xrightarrow{NaOH\,(aq.)} NaNO_3$

$+5$ HNO_3 ← $+5$ $P_2O_5 \xrightarrow{NaOH\,(aq.)} Na_3PO_4$

H_3PO_4 ←

Reaction with $NaOH_{(aq)}$



Amphoteric Oxides :

H_2ZnO_2 — ZnO $\xrightarrow{NaOH}$ Na_2ZnO_2

H_2PbO_2 — PbO $\longrightarrow$ Na_2PbO_2 (Pb^{+2})

H_2PbO_3 — PbO_2 $\longrightarrow$ Na_2PbO_3 (Pb^{+4})

SnO $\longrightarrow$

SnO_2 $\longrightarrow$

H_2BeO_2 — BeO $\longrightarrow$ Na_2BeO_2

ate : HOS

ite : LOS

NaOH

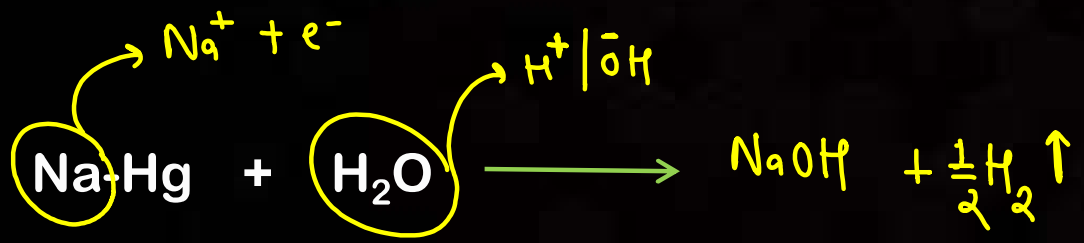
Caustic Soda

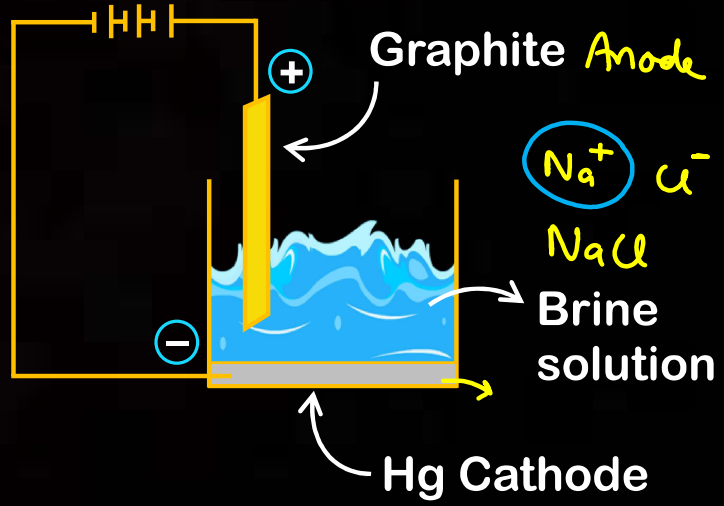
Castner Kellner's Cell

Reduction

Cathode : $Na^+ + e^- \xrightarrow{Hg}$ Na – Hg (Alloy)

Anode : (Oxidⁿ) $Cl^- \longrightarrow \frac{1}{2} Cl_2 \uparrow + e^-$



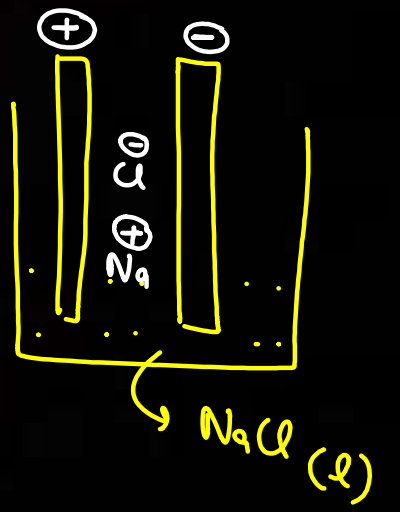


The amalgam is treated with water to give NaOH & H_2.

Dawn Cell

Fused NaCl is electrolyzed at a 330°C temperature for extraction of sodium.

A mixture of KCl and KF is added to sodium chloride to decrease M.P. of NaCl.

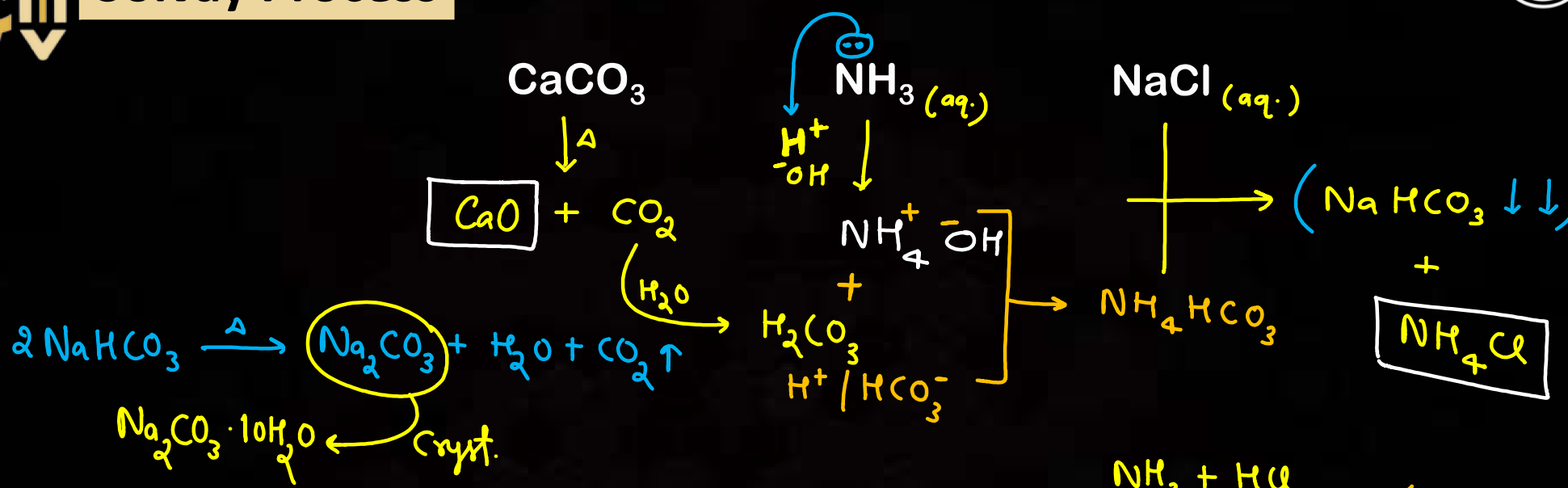


Cathode : $Na^+ + e^- \longrightarrow Na$

Anode : $Cl^- \longrightarrow \frac{1}{2}Cl_2\uparrow + e^-$

Solvay Process

Washing Soda $Na_2CO_3 \cdot 10H_2O$



Recovery of NH_3 $CaO + H_2O \longrightarrow Ca(OH)_2 \xrightarrow[NH_4Cl]{NH_3 + HCl} CaCl_2 + NH_3\uparrow$

Q. K_2CO_3 can not be prepared by this method ? **Why** ($KHCO_3$ Soluble in water)

Soda Ash $Na_2CO_3 \cdot 10H_2O \longrightarrow Na_2CO_3 \cdot H_2O \longrightarrow Na_2CO_3$

Some Important compounds of Calcium

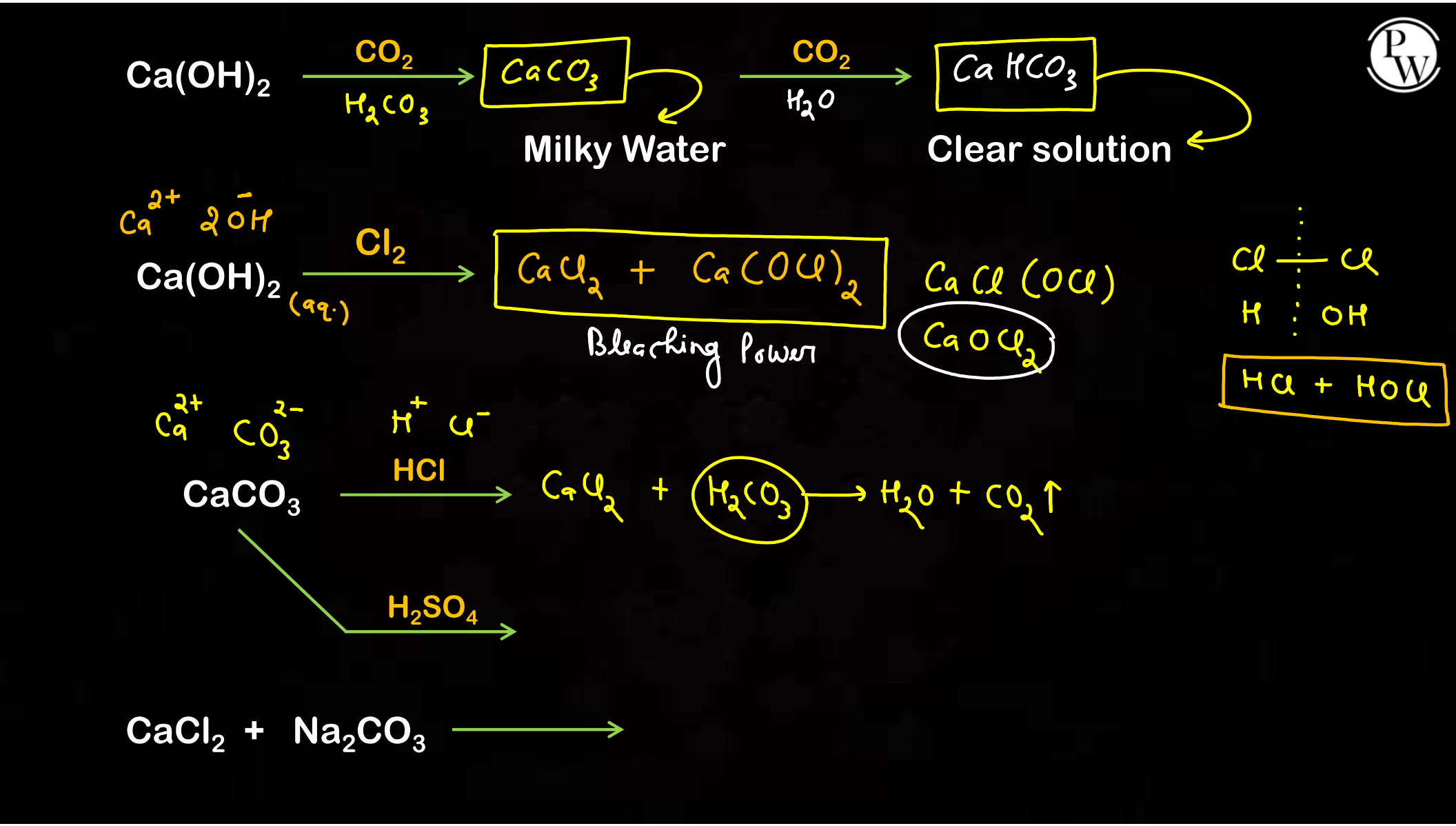
Lime stone $\xrightarrow{\Delta}$ Quick lime $\xrightarrow{H_2O}$ Slaked lime $\xrightarrow{H_2O}$ Milk of lime $\xrightarrow{H_2O}$ Lime water

$CaCO_3$ CaO $Ca(OH)_2$ (Suspension) (Clear soln)

The addition of limited amount of water breaks the lump of lime. This process is called **slaking of lime**.

Slaked lime is a white amorphous powder. It is sparingly soluble in water. The aqueous solution is known as **lime water** and a suspension of slaked lime in water is known as **milk of lime**.

Qick lime slaked with soda gives solid **soda – lime** .


Ca(OH)2
CO2
H2CO3
CaCO3
Milky Water
CO2
H2O
Ca HCO3
Clear solution
Ca2+ 2OH-
Ca(OH)2 (aq.)
Cl2
CaCl2 + Ca(OCl)2
Bleaching Power
CaCl(OCl)
CaOCl2
Cl Cl
H OH
HCl + HOCl
Ca2+ CO3 2-
CaCO3
H+ Cl-
HCl
CaCl2 + H2CO3 → H2O + CO2↑
H2SO4
CaCl2 + Na2CO3

$CaSO_4$

Gypsum

$CaSO_4 \cdot 2H_2O$

Plaster of Paris (POP)

Hemi-hydrate of $CaSO_4$

$CaSO_4 \cdot \frac{1}{2} H_2O$

Gypsum

$$CaSO_4 \cdot 2H_2O \xrightarrow{\Delta} \underset{\text{POP}}{CaSO_4 \cdot \tfrac{1}{2} H_2O} \xrightarrow{393\ K} CaSO_4$$

dead burnt plaster

NaCl

Sea Water $\xrightarrow{\text{Evaporation}}$ Raw Salt

Impurity

$NaCl + MgCl_2 + CaCl_2$

$NaCl_{(s)}$ ← $HCl_{(aq.)}$

H.W.

Q. HCl was passed through a solution of $CaCl_2$, $MgCl_2$ and NaCl. Which of the following compound(s) crystallize (s) ?

(A) Only NaCl

(B) Only $MgCl_2$

(C) NaCl, $MgCl_2$ and $CaCl_2$.

(D) Both $MgCl_2$ and $CaCl_2$

Uses

"Jwala OP"

Li → Electro chemical cell

Liquid sodium metal → Coolant in fast breeder nuclear reactors.

$Mg(OH)_2$: Milk of magnesia : Antacid in medicine

Ra : Radiotherapy (treatment of cancer)

KO_2 : used in oxygen cylinders in space and submarines

Beryllium is used in the manufacture of alloys. Copper -beryllium alloys are used in the preparation of high strength springs.

Magnesium-aluminium alloys being light in mass are used in air-craft construction.

Biological Importance of Sodium and Potassium

(Top)

K^+ ions are the most abundant cations within cell fluids, where they activate many enzymes, participate in the oxidation of glucose to produce ATP and, with Na, are responsible for the transmission of nerve signals.

Sodium ions are found primarily on the outside of cells

Sodium-potassium pump ?

Main pigment for the absorption of light in plants is chlorophyll which contains magnesium

Mg

Biological Importance of Magnesium and Calcium

All enzymes that utilise ATP in phosphate transfer require magnesium as the cofactor.

The main pigment for the absorption of light in plants is chlorophyll which contains Mg.

Q. Match List -I with List-II for the compositions of substances and select the correct answer using the code given below the lists :

List – I (Substances)		List – II Composition
(1) Plaster of paris	(i)	$CaSO_4.\ 2H_2O$
(2) Epsomite	(ii)	$CaSO_4.\ ½\ H_2O$
(3) Kieserite	(iii)	$MaSO_4.\ 7H_2O$
(4) Gypsum	(iv)	$MgSO_4.\ H_2O$
	(v)	$CaSO_4$

H.W.

Code:

A (1) – (iii), (2) – (iv), (3) – (i), (4) – (ii)

B (1) – (ii), (2) – (iii), (3) – (iv), (4) – (i)

C (1) – (i), (2) – (ii), (3) – (iii), (4) – (v)

D (1) – (iv), (2) – (iii), (3) – (ii), (4) – (i)

HOME WORK

Q. The following metal ion activates many enzymes, participates in the oxidation of glucose to produce ATP and with Na, is responsible for the transmission of nerve signals.

A. Copper

B. Calcium

C. Potassium

D. Iron

Answer : C

Q. The function of “Sodium pump” is a biological process operating in each and every cell of all animals. Which of the following biologically important ions is also a constituent of this pump :

A. Mg^{2+}

B. K^{+}

C. Fe^{2+}

D. Ca^{2+}

Answer : B

Q. In which of the following processes, fused sodium chloride is electrolyzed at a 330°C temperature for extraction of sodium ?

A. Castner's process

B. Down's process

C. Cyanide process

D. Both 'b' and 'c'

Answer : B