CHEMICAL BONDING

Note :- if $\Delta H_{diss.}$ (enthalpy of dissolution) is $-ve$ then salt will be soluble and breaks into ion.

$$
\begin{tikzcd}[column sep=large, row sep=huge]
NaCl(s) + aq. \arrow[rr] \arrow[d, "LE(NaCl)"] & & Na^+(aq.) + Cl^-(aq) \quad \underline{\Delta H_{diss}} \\
Na^+(g) + Cl^-(g) \arrow[urr, "HE(Na^+)"] \arrow[urr, shift right=3, "HE(Cl^-)"'] & &
\end{tikzcd}
$$

$$\Delta H_{dis}(NaCl) = \underbrace{LE(NaCl)}_{\substack{\text{endothermic} \\ (+ve)}} + \underbrace{HE(Na^+) + HE(Cl^-)}_{\substack{\text{exothermic} \\ (-ve)}}$$

47*. Is a data sufficiency problem in which it is to be decided on the basis of given statements whether the given question can be answered or not. (No matter whether the answer is yes or no)

If $\Delta H_{solution} < 0$ then compound acts as ionic in aqueous solution. Is $AlCl_3(s)$ ionic in aqueous solution.

Statement 1 : L.E. of $AlCl_3$ is 5137 kJ/mol

Statement 2 : ΔH_{HE} of Al^{+3} ion is – 4665 kJ/mol^{-1} & ΔH_{HE} of Cl^- is –381 kJ/mol^{-1}

(A) Statments (A) alone is sufficient but statement (B) is not sufficient

(B) Statments (B) alone is sufficient but statement (A) is not sufficient

(C) Both statement together are sufficient but neither statement alone is sufficient ✓

(D) Statement (A) & (B) together are not sufficient

$$
\begin{tikzcd}
AlCl_3(s) + aq. \arrow[r] \arrow[d, "LE(AlCl_3)"'] & Al^{+3}(aq.) + 3Cl^-(aq.) \\
Al^{+3}(g) + 3Cl^-(g) \arrow[ur, "HE(Al^{+3})", "3\ HE(Cl^-)"'] &
\end{tikzcd}
$$

$$\Delta H_{diss} = 5137 + (-4665) + 3(-381)$$

$$= 5137 - 5808 = -671 \text{ kJ/mol} < 0$$

IONIC BOND/ELECTROVALENT BOND

- **Boiling point and melting point :-**

  Ionic compounds have high boiling point and melting point due to strong electrostatic force of attraction among oppositely charged ions.

- **Conductivity :-**

  In solid state these are bad conductor of electricity due to absence of free mobile ion. In fused state or aqueous solution Due to presence of free ions they are Good conductor of electricity.

  Conductivity order $\longrightarrow$ [Solid state < fused state < Aqueous solution]

- **Solubility** :-

  Generally more soluble in Polar solvents like water.

  Less soluble in non polar solvents like benzene.

  Ex. NaCl form a true solution in water but insoluble in CCl_4.

CHEMICAL BONDING

LATTICE ENERGY

Definition :-

The amount of energy released when gaseous cation and anion are combined to form one mole of ionic compound solid is called lattice energy .

- It depends upon electrostatic force of attraction and affect the stability of compounds .
- **Factors affecting Lattice energy :-**

(1) L.E. α Z^+, Z^- (Where Z^+, Z^- are charges of cation and anion respectively)

(2) L.E. α $\frac{1}{r^+ + r^-}$ (Where r^+ and r^- are the radius of cation and anion respectively)

CHEMICAL BONDING

Question

Q. **Arrange the following in the correct order of lattice energy :**

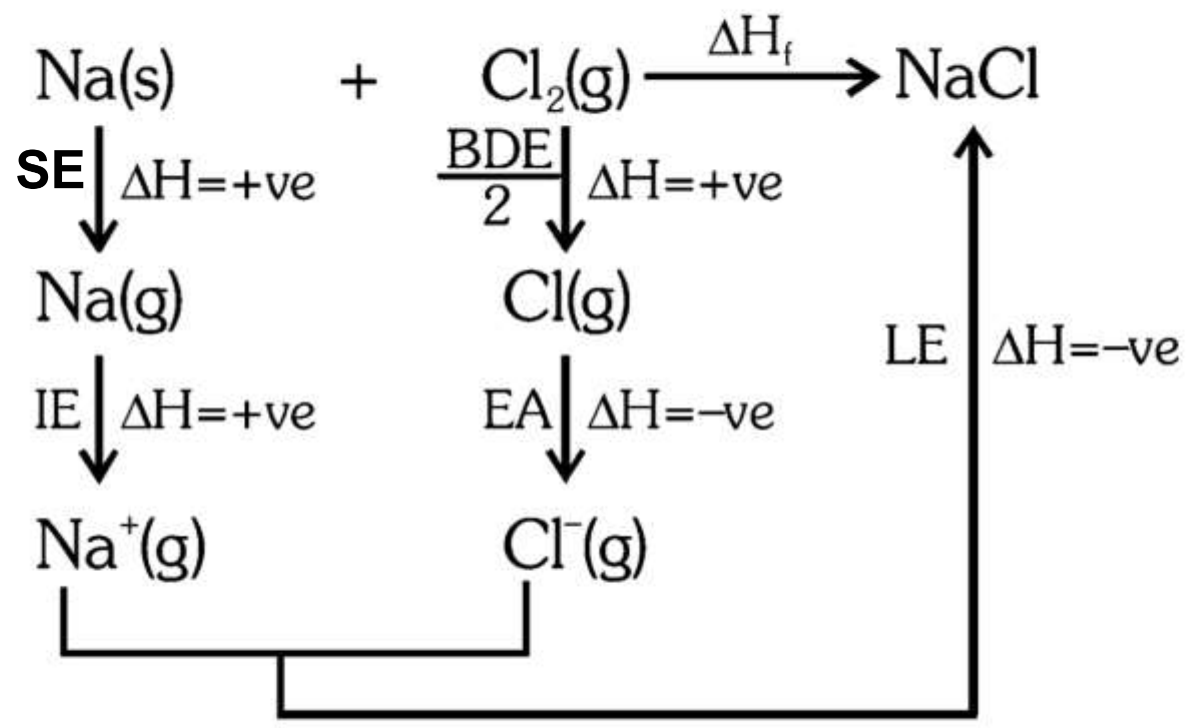
(1) Na_2O MgO Al_2O_3 $\longrightarrow$

(2) AlF_3 Al_2O_3 AlN $\longrightarrow$

(3) $LiCl$ $NaCl$ KCl $RbCl$ $CsCl$ $\longrightarrow$

BORN HABER'S CYCLE

(Mechanism of ionic bond formation)



$$\Delta Hf = \underbrace{SE + IE + \frac{BDE}{2}}_{\text{Endo}(\Delta H='+'\text{ve})} + \underbrace{\Delta H_{eg} + LE}_{\text{Exo}(\Delta H='-'\text{ve})}$$

BORN HABER'S CYCLE

Favourable conditions for ionic bond formation :-

$\left.\begin{array}{l}\text{Low SBE}\\ \text{Low IE}\\ \text{Low BDE}\end{array}\right\}$ **Absorbed energy**

$\left.\begin{array}{l}\text{High } \Delta H_{eg}\\ \text{High L.E.}\end{array}\right\}$ **Released energy**

Born Haber's Cycle:-

$$\underbrace{SBE + IE + \tfrac{1}{2} BDE}_{\text{(Endothermic process)}} > \underbrace{\Delta H_{eg} - L.E.}_{\text{(Exothermic process)}}$$

Case no. 1 :- If ΔH_f is more (–) ve then the compound is more stable .

Case no. 2 :- If ΔH_f is less (–) ve then the compound is less stable .

Case no. 3 :- If ΔH_f is (+) ve then the compound is unstable .

Question

Q. Heat of sublimation of Na = x J

Ionization energy of Na= y J

Bond dissociation energy of Cl_2 = a J

e^- gain enthalpy of Cl = b J

Enthalpy of formation of NaCl = c J

Then what will be lattice energy of NaCl(s) = ?

Sol.

HYDRATION ENERGY

- Amount of energy released in the hydration of one mole of ionic crystal is known as **Hydration energy.**
- If this released amount of energy (HE) is greater than amount of energy required to break the bond (LE) , then substance is considered as soluble.

Dielectric constant :-

Capacity of a medium to minimize interionic attraction by neutralizing the charge of ions is known as dielectric constant.

E.g.:- $HF \longrightarrow 120$

$H_2SO_4 \longrightarrow 102$

$H_2O \longrightarrow 81$

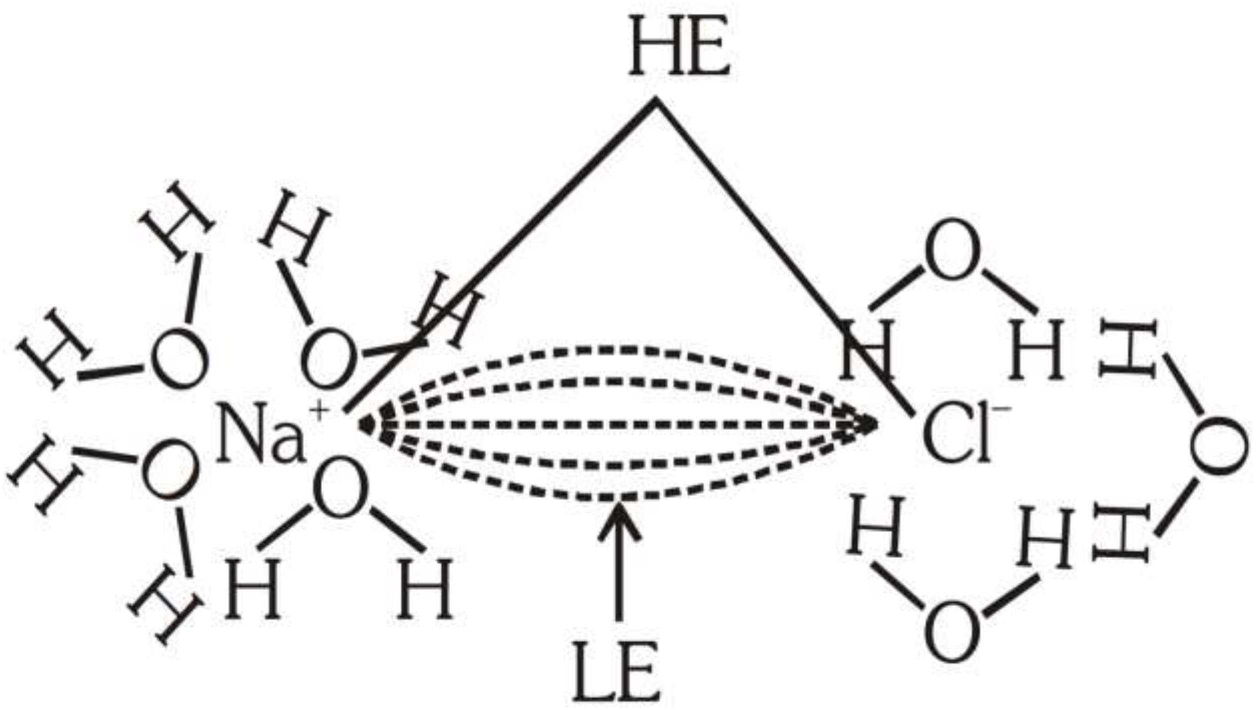
$D_2O \longrightarrow 78$

MECHANISM OF SOLVENCY

(Ion – dipole attraction)

Solute :- NaCl (s)

Solvent :- H_2O



(Electrostatic force of attraction)

L.E. - lattice energy
H.E. - Hydration energy

Case no. 1 :- HE > LE (then more soluble)

Case no. 2 :- HE < LE (then sparingly soluble / insoluble)

HYDRATION ENERGY

Factors Affecting HE:-

(1) HE α charge (Z^+ Z^-)

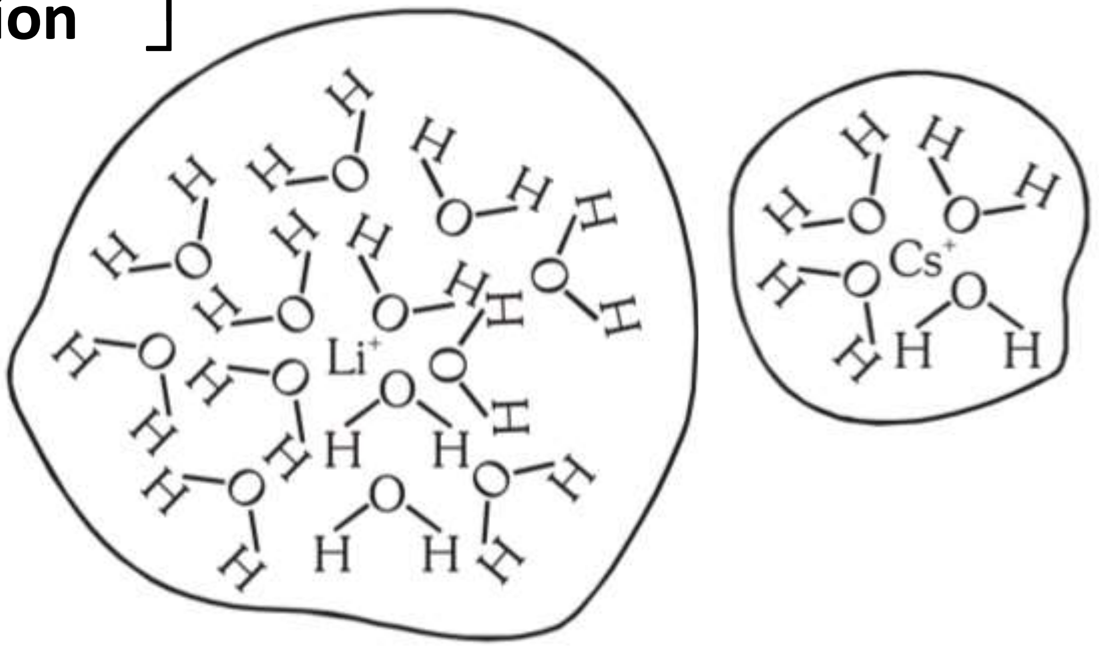
(2) HE α $\dfrac{1}{r^+} + \dfrac{1}{r^-}$

Hydration tendency :-

$$\left[\text{Hydrogen tendancy} \propto \frac{\text{Charge on ion}}{\text{size of ion}}\right]$$

Li^+ Na^+ K^+ Rb^+ Cs^+ $\longrightarrow$

r^+ (↑) Hydration tendency (↓)



HYDRATION ENERGY

E.g. :- **(In Aqueous solution)**

Li^+ Na^+ K^+ Rb^+ Cs^+

Ionic Radius (↑) $\longrightarrow$

Hydrated radii (↓)

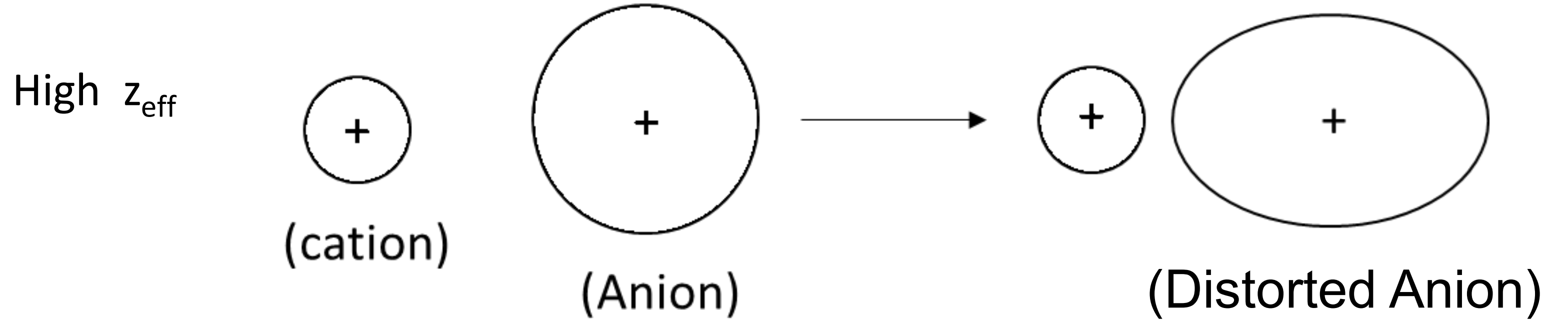
Movement of ions (↑)

Ionic mobility (↑)

Ionic conductivity (↑)

POLARISATION (FAJAN'S RULE)

- Covalent character in an ionic compounds can be explained with the help of polarisation .
- Distortion in the e^{-} cloud of an anion due to the attraction of adjacent cation.
- Due to polarisation, covalent character are produced.



- For cation :- **Polarising power** term is used .
- For anion :- **Polarisability** term is used .

POLARISATION (FAJAN'S RULE)

Polarising power :-

It is the power of cation to attract electron cloud of an anion towards itself.

Factors affecting polarising power :-

$$\left[\text{Polarizing power} \;\; \alpha \;\; \underbrace{\frac{\text{Charge of cation}(Z^{+})}{\text{Size of cation}(r^{+})}}_{\text{Ionic potential}(\phi)} \right]$$

[Polarizing power α Ionic potential (ϕ)]

CHEMICAL BONDING

POLARISATION (FAJAN'S RULE)

- **Polarisability :-** It is the ability of an anion to get polarized by adjacent cation.

Factors affecting Polarizability :-

Polarizability $\propto$ (-ve) Charge of anion
Polarizability $\propto$ Size of anion

- **Effective conditions of polarisation :-**

(1) Size of cation should be smaller.
(2) Size of anion should be large.
(3) Charge on cation/anion should be High .

E.g. :-

$$\xrightarrow[\text{Size of cation}\uparrow \quad \text{Polarisation}\downarrow \quad \text{Covalent character}\downarrow]{BeCl_2 \quad MgCl_2 \quad CaCl_2 \quad SrCl_2 \quad BaCl_2}$$

Size of cation $\uparrow$
Polarisation $\downarrow$
Covalent character $\downarrow$

CHEMICAL BONDING

POLARISATION (FAJAN'S RULE)

E.g. :-

$BeCl_2 \quad MgCl_2 \quad CaCl_2 \quad SrCl_2 \quad BaCl_2$
$$\longrightarrow$$

Size of cation -
Polarisation ¯
Covalent character ¯

CHEMICAL BONDING

POLARISATION (FAJAN'S RULE)

(2) $\xrightarrow[\text{Charge on cation}\uparrow]{\overset{+1}{NaCl}\quad \overset{+2}{MgCl_2}\quad \overset{+3}{AlCl_3}\quad \overset{+4}{SiCl_4}}$

polarisaton $\uparrow$

Covalent character $\uparrow$

(3) $\xrightarrow[\text{Charge on Anion}\uparrow]{AlF_3^{-1}\quad Al_2O_3^{-2}\quad AlN^{-3}}$

Polarisation $\uparrow$

Covalent character $\uparrow$

CHEMICAL BONDING

POLARISATION (FAJAN'S RULE)

Compare covalent character in the following sequences

Q. $CrO \quad Cr_2O_3 \quad CrO_3$ $\longrightarrow$

Q. $\overset{+}{Li}Cl \quad \overset{+}{Na}Cl \quad \overset{+}{K}Cl \quad \overset{+}{Rb}Cl \quad \overset{+}{Cs}Cl$ $\longrightarrow$

Q. $PbF_2 \quad PbCl_2 \quad PbBr_2 \quad PbI_2$ $\longrightarrow$

POLARISATION (FAJAN'S RULE)

Order of polarizing power for some special type of cations :-

- **Stability of Cations :-**

Inert gas configuration	> Pseudo inert gas configuration	> Inert pair effect
($8\ e^-$)	($18\ e^-$)	($18 + 2e^-$)

- **Order of polarizing power of Cations :-**

Pseudo inert gas configuration	> Inert pair effect	> Inert gas configuration
($18\ e^-$)	($18 + 2e^-$)	($8\ e^-$)

Example of cation . :-

$$\overset{+}{Na}Cl < \overset{+}{T\ell}Cl < \overset{+}{Cu}Cl$$

$$(8e^-) \quad (18 + 2e^-) \quad (18e^-)$$

POLARISATION (FAJAN'S RULE)

Q. Among LiCl, $BeCl_2$, BCl_3 and CCl_4, the covalent bond character follows the order :

(1) $LiCl < BeCl_2 > BCl_3 > CCl_4$

(2) $LiCl > BeCl_2 < BCl_3 < CCl_4$

(3) $LiCl < BeCl_2 < BCl_3 < CCl_4$

(4) $LiCl > BeCl_2 > BCl_3 > CCl_4$

POLARISATION (FAJAN'S RULE)

Q. Which one of the following show correct order of covalent character ?

(1) $ZnO < ZnS$

(2) $ZnS = ZnO$

(3) $ZnS < ZnO$

(4) None

CHEMICAL BONDING

(I)

Melting points

• Cation is from

S-Block

IC > 50%

all are ionic

$m.p \propto LE$

$\boxed{\text{Ionic (mp)} > \text{Co-valent (mp)}}$

d-Block

IC < 50%

IC < 50%

$m.p \propto \frac{1}{\text{polarisation}}$

$IC \propto \frac{1}{\text{polarisation}}$

$\text{Polarisation} \propto \frac{q_c}{r_c} + q_a r_a$

P-Block

compound having ionic bond but IC < 50%

determined as d-Block

if packing is good the LE will be very high.

CHEMICAL BONDING

Ex. Compare the melting point of following

(i) $\overset{+1}{Na}\overset{-1}{Cl} < \overset{+2}{Mg}\overset{-2}{O} < \overset{+3}{Al}\overset{-3}{N}$ LE ∝ $|q_c q_a|$

(ii) $\overset{+1}{Na_2}\overset{-2}{O} > \overset{+1}{Na}\overset{-1}{Cl}$ LE ∝ q_a

* $\overset{+2}{Fe}O < \overset{+3}{Fe_2}O_3$ LE ∝ q_c

(iii) $\overset{+2}{Pb}Cl_2 > \overset{+4}{Pb}Cl_4$ Polarisation ∝ q_c

(iv) $\overset{+1}{Na_2}\overset{-2}{O} > \overset{-1}{Na_2}\overset{-2}{S}$ LE ∝ $\frac{1}{r_a + r_c}$

(v) $\overset{+1}{Na}Cl > \overset{+2}{Mg}Cl_2$ → IC < 50% Polarisation

(vi) $ZnCl_2 < CaCl_2$ [psuedo inert gas]

Li^+, Al^{+3}, Be^{+2}, Mg^{+2}

$\boxed{F^-, O^{-2}, N^{-3}}$

ही ज्यादा ionic होते है!

IC > 50%

CHEMICAL BONDING

vii) LiF > $LiCl$ [Polarisation]

viii) $BeCl_2$ < , $MgCl_2$ < $CaCl_2$ < $SrCl_2$, < $BaCl_2$
[Polarisation]

ix) CaF_2 > $CaCl_2$ > $CaBr_2$ > CaI_2 [Polarisation]

** For Chloride, bromide and Iodide of group (IIA) and Li melting point is determined by polarisation because their IC < 50% for → their
- Chloride
- Iodide
- bromide

CHEMICAL BONDING

→ ΔEN
→ LE
→ packing

Exception :

Cl^- (medium)

Li^+ small — Na^+ Comparable — Cs^+ Large

- $NaCl > KCl > RbCl > CsCl > LiCl$
- $MgO > CaO > BeO > SrO > BaO$
- $NaF > KF > LiF > RbF > CsF$
- $KI > NaI > RbI > CsI > LiI$

CHEMICAL BONDING

Boiling point

s Block | d Block | ionic of p-Block Compound

Co-valent compound of p-Block

$$\text{Boiling point} \propto \frac{1}{\text{polarisation}} \propto \%\ \text{IC}$$

CHEMICAL BONDING

Ex. Compare Boiling point of following.

(i) $PbBr_2 > PbBr_4$

ii) $SnCl_2 > SnCl_4$

iii) $FeCl_2 > FeCl_3$

iv) $\overset{+1}{Na}Cl > \overset{+2}{Mg}Cl_2$

v) $Na_2\overset{-2}{O} < Na\overset{-1}{F}$

vi) $ZnCl_2 < CaCl_2$ [$ZnCl_2$ more co-valent because of pseudo inert configuration

vii) $BeCl_2 < MgCl_2$

CHEMICAL BONDING

$$\phi = \frac{q_c}{r_c} + q_a r_a$$

viii) $LiF > LiCl$

ix) $\overset{+2}{Be}Cl_2 < \overset{+2}{Mg}Cl_2 < \overset{+2}{Ca}Cl_2 < \overset{+2}{Sr}Cl_2 < \overset{+2}{Ba}Cl_2$

r_c increases polarisation decreases

x) $AgF > AgCl > AgBr > AgI$

xi) $CaF_2 > CaCl_2 > CaBr_2 > CaI_2$

CHEMICAL BONDING

Electrical

Conductance

Molten state / Gasseous state

Conductance $\propto \frac{1}{\text{Radius}}$

OR

mobility

Aqueous state

Conductance $\propto \frac{1}{\text{Hydrated Rad.}}$

or

mobility

CHEMICAL BONDING

APPLICATION OF FAJAN'S RULE

SOLUBILITY :-

LIKE DISSOLVES LIKE

- Ionic compounds are soluble in polar solvents like H_2O.
- Polar Covalent compounds are soluble in polar organic solvents like acetone, ether
- Non polar compounds are more soluble in non polar solvents like benzene, CCl_4.

Ex. Select the true statements ?

T (i) NaCl will more dissolve than LiCl in H_2O

F (ii) LiCl will more dissolve than NaCl in H_2O

T iii) LiCl will more dissolved than NaCl in benzene

CHEMICAL BONDING

$$A_x B_y + aq. \longrightarrow x\,A^{+y}(aq.) + y\,B^{-x}(aq.)$$

$$\boxed{\Delta H_{diss} = \underbrace{LE(A_x B_y)}_{(+ve)} + \underbrace{x\,HE(A^{+y}) + y\,(HE(B^{-x}))}_{(-ve)}}$$

if $\Delta H_{diss} < 0$, salt will be more soluble.

Factor affecting solubility

(i) If Lattice energy increases solubility decreases

(ii) If Hydration increases solubility Increases.

CHEMICAL BONDING

LiF NaF KF RbF CsF

$\longrightarrow$

(1) LE energy decreases $LE \propto \frac{q_c q_a}{r_c + r_a}$

(ii) HE energy decrease $HE \propto \left(\frac{q_c}{r_c}\right) + \left(\frac{q_a}{r_a}\right)$

from statement ① on going down the group LE decrease Solubility increase LiF < NaF < KF < RbF < CsF

from statement (2) on going down the group HE decreases so solubility decreases

LiF > NaF > KF > RbF > CsF

CHEMICAL BONDING

- if common ion is large (Anion)

$$LE \propto \frac{K q_c q_a}{\cancel{r_c} + r_a} \qquad , \qquad r_a >>> r_c$$

$$LE \propto \frac{K q_c q_a}{r_a} \qquad ,$$

Lattice energy remains almost constant

$$HE \propto \underbrace{\frac{q_c}{r_c} + \frac{q_a}{r_a}}$$

We can't neglect any term ✓

✓ $\boxed{\text{Solubility} \propto HE}$

CHEMICAL BONDING

(ii) Common ion (Anion) is small

$$LE = \frac{K q_c q_a}{r_c + \cancel{r_a} \to 0}$$

$$LE = \frac{K q_c q_a}{r_c}$$

direct relation

$$\boxed{\text{• Solubility} \propto \frac{1}{LE}}$$

$$HE \propto \frac{q_c}{r_c} + \frac{q_a}{r_a}$$

$r_c \approx r_a$

$$HE \propto \frac{q_c + q_a}{r_a}$$

HE ÷ remains constant:

CHEMICAL BONDING

Soubility

Cation is from

S-Block

Common Ion Small

Solubility $\propto \frac{1}{LE}$

Common Ion Large

Solubility $\propto$ HE

d-Block | P-Block

Solubility $\propto$ %IC

✓ Solubility $\propto \frac{1}{\text{polarisation}}$

SOLUBILITY

(A) Solubility of ionic compounds of s-block:

(i) Solubility $\propto$ Hydration energy

(ii) $$\text{Solubility} \propto \frac{1}{\text{Lattice energy}}$$

**

- If common ion is smaller than apply L.E.
  (F^-, O^{-2}, OH^-, Li^+, Mg^{+2}, Be^{+2} etc.)

- If common ion is larger than apply H.E.
  (CO_3^{-2}, SO_4^{-2}, NO_3^-, ClO_4^-, HCO_3^-, Cs^+ etc.)
  $C_2O_4^{-2}$, ClO_3^-, $S_2O_3^{-2}$,

SOLUBILITY

Q. **Compare Solubility in following :-**

(1) $\overset{+1}{Li_2O}$ $\overset{+1}{Na_2O}$ $\overset{+1}{K_2O}$ $\overset{+1}{Rb_2O}$ $\overset{+1}{Cs_2O}$ $\longrightarrow$

$r_c \uparrow$ $LE \downarrow$

solubility $\uparrow$

(Common ion O^{-2} , Apply L.E.)

Size(↑) , L.E. (↓) , Solubility (↑)

(2) $\overset{-1}{CsF}$ $\overset{-1}{CsCl}$ $\overset{-1}{CsBr}$ $\overset{-1}{CsI}$ $\longrightarrow$

$r_a \uparrow$ $HE \downarrow$

solubility $\downarrow$

(Common ion Cs^+, Apply H.E.)

Size(↑) , H.E.(↓) , Solubility (↓)

SOLUBILITY

(3) $Be(OH)_2$ $Mg(OH)_2$ $Ca(OH)_2$ $Sr(OH)_2$ $Ba(OH)_2$

(Common ion OH^- ,Apply L.E.)

Size(↑) , L.E. (↓) , Solubility (↑)

(4) $BeSO_4$ $MgSO_4$ $CaSO_4$ $SrSO_4$ $BaSO_4$

(Common ion SO_4^{-2},Apply H.E.)

Size(↑) , H.E.(↓) , Solubility (↓)

SOLUBILITY

(B) Solubility of ionic compounds of p and d block:

$$\text{Solubility} \propto \frac{1}{\text{Covalent character}}$$

E.g. :-

$$\xrightarrow{\text{AgF} \quad \text{AgCl} \quad \text{AgBr} \quad \text{AgI}}$$

Size of anion ↑
Covalent character ↑
Solubility ↑

Ex. $ZnCl_2$ < $CaCl_2$ (psuedo inert)

SOLUBILITY

Q. Compare solubility in following sequence.

(i) PbF_2 $PbCl_2$ $PbBr_2$ PbI_2

Size of anion(↑) ⟶

Covalent character (↑)

Solubility (↓)

(ii) $SnCl_2$ $SnCl_4$

Charge of cation (↑) ⟶

Covalent character (↑)

Solubility (↓)

Ex. Compare solubility of following compounds.

(1) $\overset{+1}{Li}ClO_4 > \overset{+1}{Na}ClO_4 > \overset{+1}{K}ClO_4 > \overset{+1}{Rb}ClO_4 > \overset{+1}{Cs}ClO_4$

ClO_4^- large common Anion. Solubility $\propto$ HE

HE(cation) $\propto \frac{q_c}{r_c}$, $r_c \uparrow$ HE $\downarrow$ solubility $\downarrow$

(2) $LiNO_3 > NaNO_3 > KNO_3 > RbNO_3 > CsNO_3$

NO_3^- large common Anion. Solubility $\propto$ HE

HE(cation) $\propto \frac{q_c}{r_c}$, $r_c \uparrow$ HE $\downarrow$ solubility $\downarrow$

(3) $CaS_2O_3 > SrS_2O_3 > BaS_2O_3$

$S_2O_3^{-2}$ large common Anion. Solubility $\propto$ HE

HE(cation) $\propto \frac{q_c}{r_c}$, $r_c \uparrow$ HE $\downarrow$ solubility $\downarrow$

(4) $BeCrO_4 > MgCrO_4 > CaCrO_4 > SrCrO_4 > BaCrO_4$

CrO_4^{-2} large common Anion. Solubility $\propto$ HE

HE(cation) $\propto \frac{q_c}{r_c}$, $r_c \uparrow$ HE $\downarrow$ solubility $\downarrow$

CHEMICAL BONDING

(5) $LiBr > NaBr > KBr > RbBr > CsBr$

Br^- large common Anion. Solubility $\propto$ HE

HE (cation) $\propto \frac{Zc}{rc}$, $r_c \uparrow$ HE $\downarrow$ solubility $\downarrow$

(5) $CaSO_3 > SrSO_3 > BaSO_3$

SO_3^{-2} large common Anion. Solubility $\propto$ HE

HE (cation) $\propto \frac{Zc}{rc}$, $r_c \uparrow$ HE $\downarrow$ solubility $\downarrow$

(6) $RbCl > RbBr > RbI$

Rb^+ large common. cation solubility $\propto$ HE

HE (cation) $\propto \frac{Za}{ra}$, $r_a \uparrow$ HE $\downarrow$ solubility $\downarrow$

(7) $CsF > CsCl > CsBr > CsI$

Cs^+ large common cation solubility $\propto$ HE

HE (cation) $\propto \frac{Za}{ra}$, $r_a \uparrow$ HE $\downarrow$ solubility $\downarrow$

CHEMICAL BONDING

(8) $NaF < KF < RbF < CsF$

F^- is common Anion is smaller solubility $\propto \frac{1}{LE}$

$LE \propto \frac{q_c q_a}{r_c + r_a}$, $r_c \uparrow$ $LE \downarrow$ Solubility $\uparrow$

(9) $LiOH < NaOH < KOH < RbOH < CsOH$

OH^- is common Anion is smaller solubility $\propto \frac{1}{LE}$

$LE \propto \frac{q_c q_a}{r_c + r_a}$, $r_c \uparrow$ $LE \downarrow$ Solubility $\uparrow$

SOLUBILITY

Exceptional Order of solubility :

(1) In IIA Fluorides BeF_2 is highly soluble due to it's high H.E.

$MgF_2 < CaF_2 < SrF_2 < BaF_2 < BeF_2$

(2) In IA CO_3^{-2}, HCO_3^- solubility increases on moving down the group.

$Li_2CO_3 < Na_2CO_3 < K_2CO_3 < Rb_2CO_3 < Cs_2CO_3$

$LiHCO_3 < NaHCO_3 < KHCO_3 < RbHCO_3 < CsHCO_3$

(3) $LiCl > CsCl > RbCl > NaCl > KCl$

** compounds of Be donot for Lattice so LE = 0, only hydration energy is there.