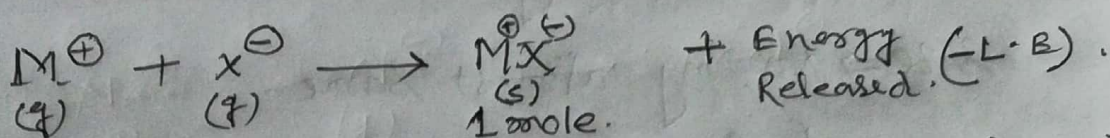
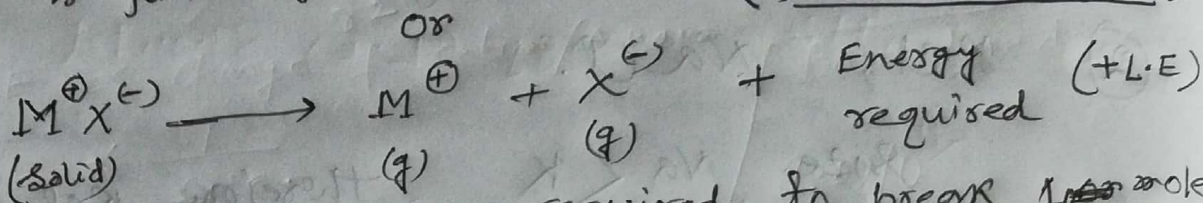


#

Lattice Energy (L.E)



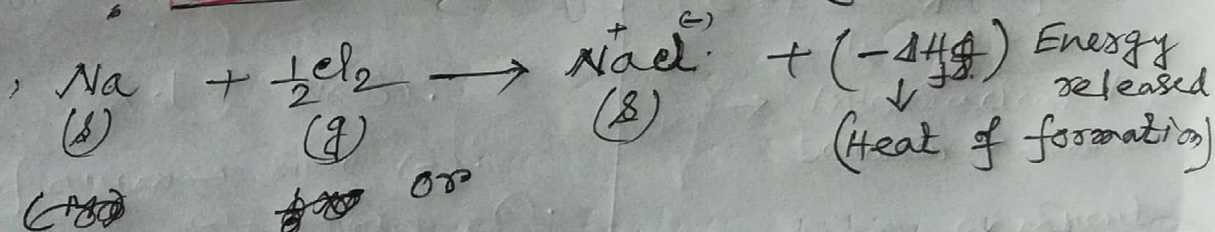
Amount of energy released when 1 mole of ionic solid is formed from the gaseous cations and anions. (Exothermic process)



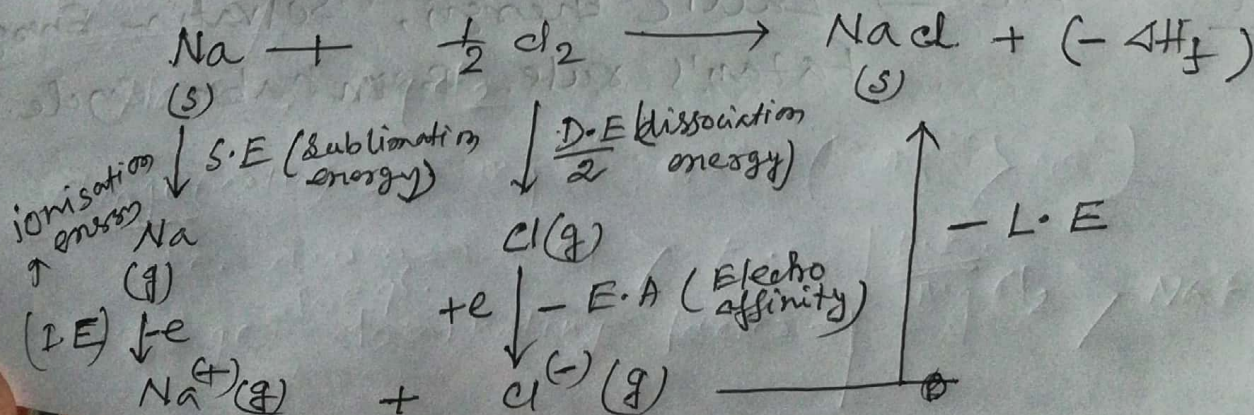
i.e. Amount of energy required to break 1 mole of ionic (compound) into solid into its gaseous cations and anions (Endothermic process)

No direct method is present to calculate the lattice energy. Some indirect method are used to calculate lattice energy of ionic compound. Born Haber cycle is used to measure the lattice E.

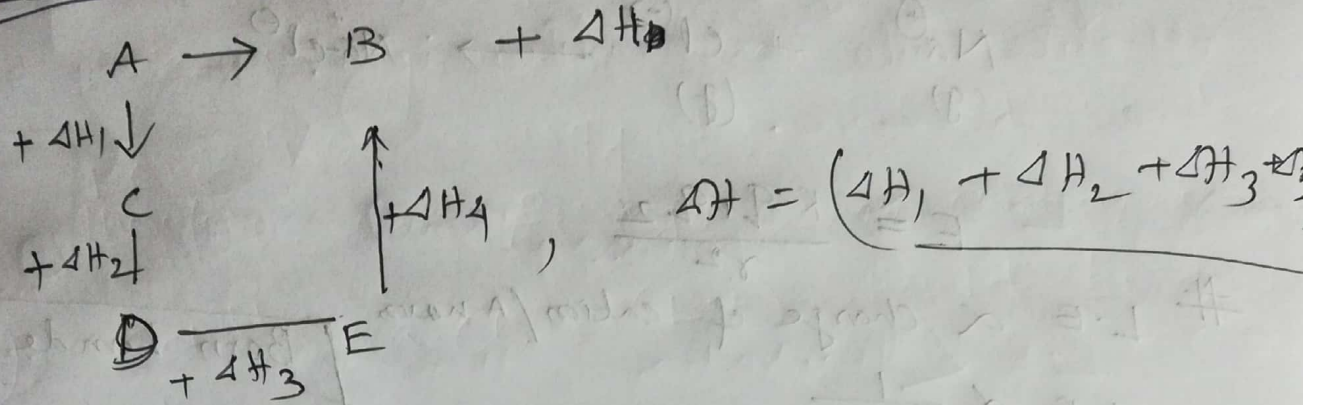
Born Haber cycle : (Indirect method)



Heat of formation: Amount of energy released when one mole of a compound is ~~for~~ formed from its pure and stable elementary state.



Hess's law



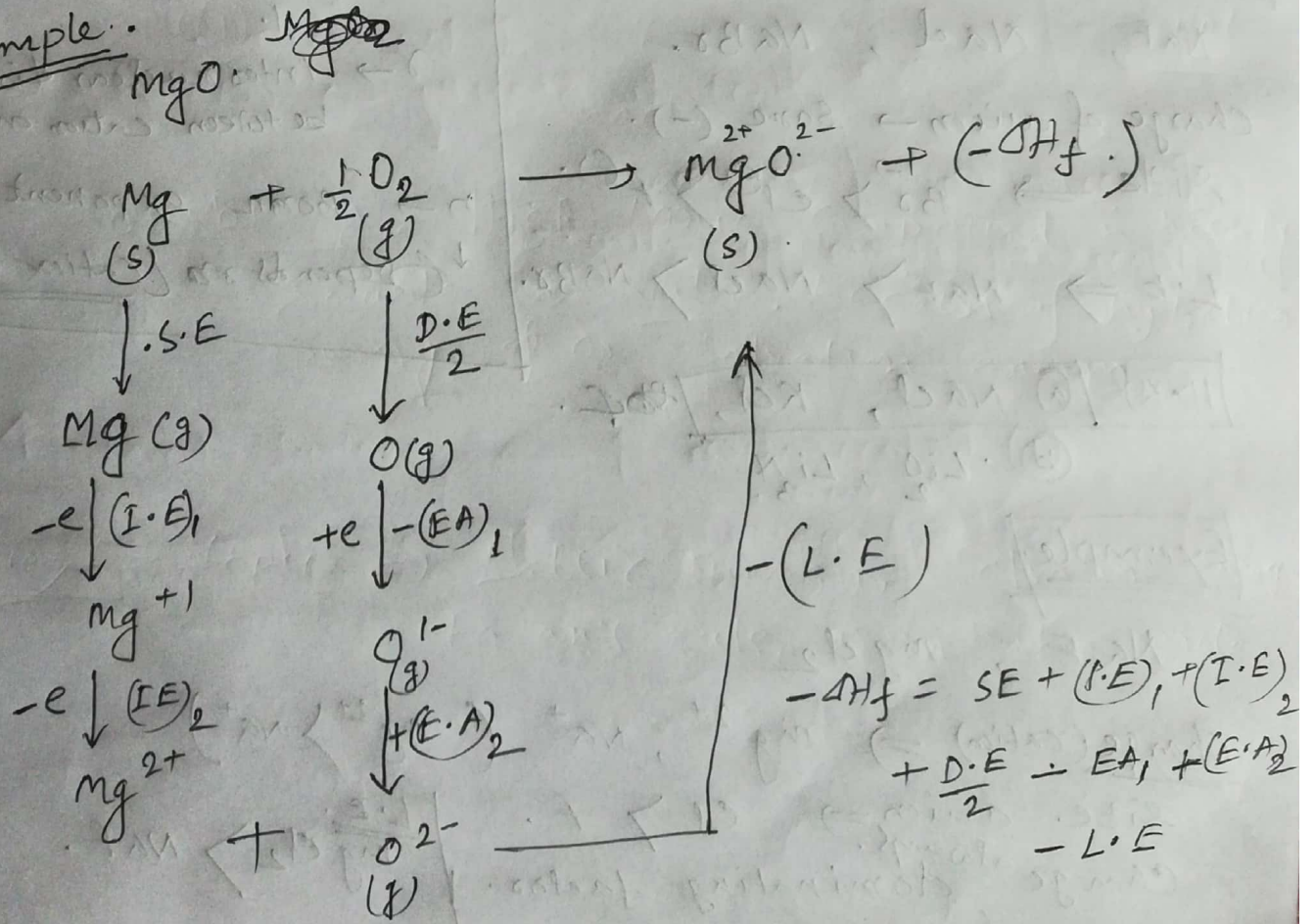
therefore,

$$-\Delta H_f = S.E + I.E + \frac{D.E}{2} - E.A - L.E$$

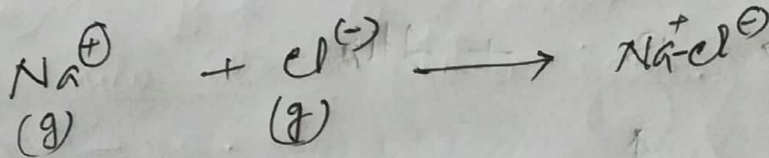
or $L.E = S.E + I.E + \frac{D.E}{2} - E.A + \Delta H_f$

$L.E = S.E + I.E + \frac{D.E}{2} - E.A + \Delta H_f$

Example



Factors on which Lattice energy depends



$$F = \frac{k q_1 q_2}{r^2}$$

L.E \propto charge of cation / Anion

L.E $\propto \frac{1}{\text{size}}$

Born Lande eqn

(L.E)/U

$$= - \frac{N_A A z_+ z_- e^2}{4\pi\epsilon_0 \cdot r} \left(1 - \frac{1}{n}\right)$$

$N_A \Rightarrow$ Avogadro number.

$A \Rightarrow$ Madelung constant

$z_+ \rightarrow$ Charge of cation

$z_- \rightarrow$ charge of anion.

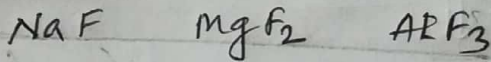
$e \rightarrow$ charge of 'e'

$r \rightarrow$ Inter nuclear distance between cation and anion

$n \rightarrow$ Born exponent

\downarrow depends on (Cation family)

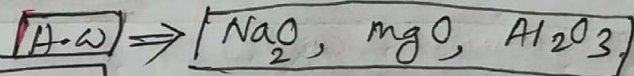
Exmp 1



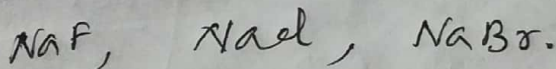
Charge \rightarrow Na⁺, Mg²⁺, Al³⁺

Size \rightarrow almost same [Same period].

L.E \Rightarrow AlF₃ > MgF₂ > NaF.



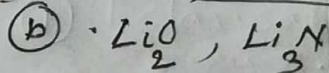
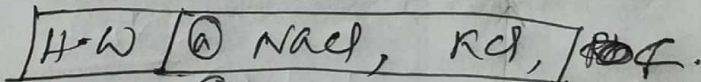
Exmp 2



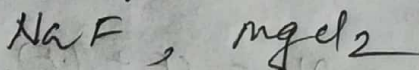
Charge of anion \rightarrow same (-).

Size \Rightarrow Br⁻ > Cl⁻ > F⁻.

L.E \Rightarrow NaF > NaCl > NaBr.



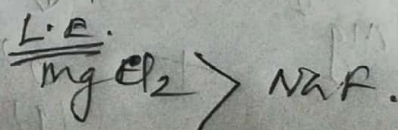
Example



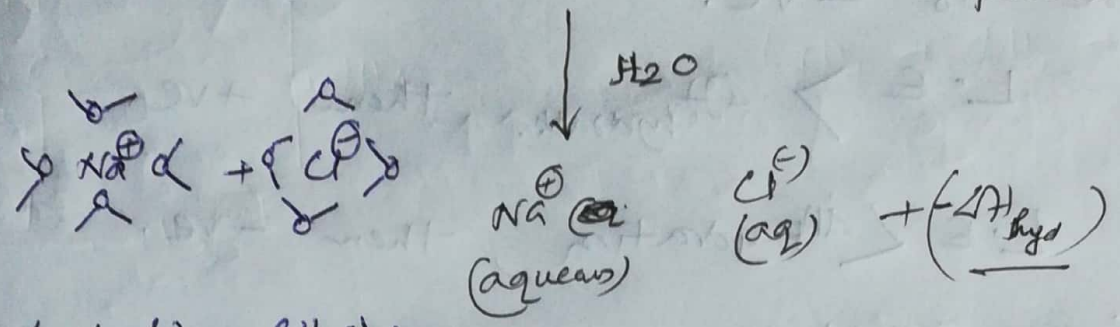
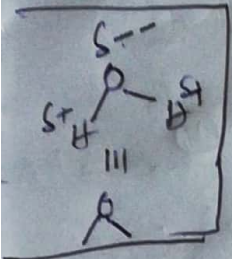
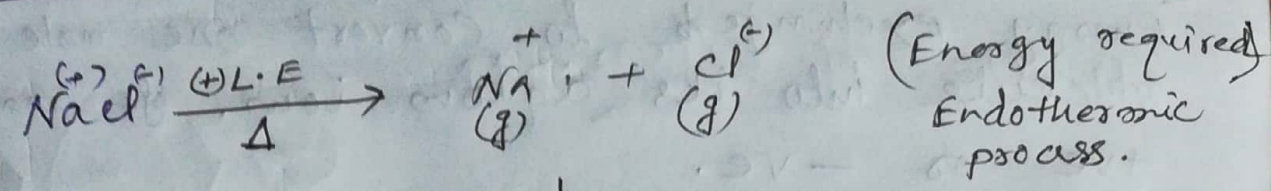
Charge (cation) \Rightarrow Mg²⁺, Na⁺ (Mg²⁺ > Na⁺)

Size. anion \Rightarrow Cl > F.

Charge always dominating factor.

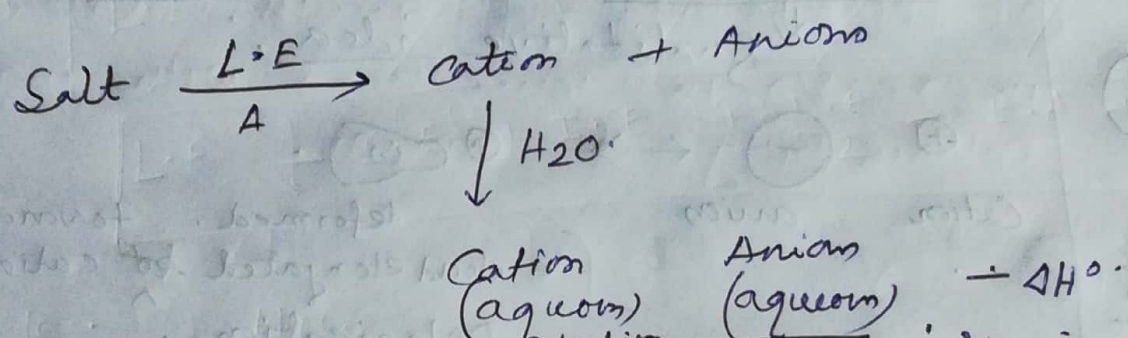


Solvation energy or (Heat of solvation)



Heat of hydration (H₂O):

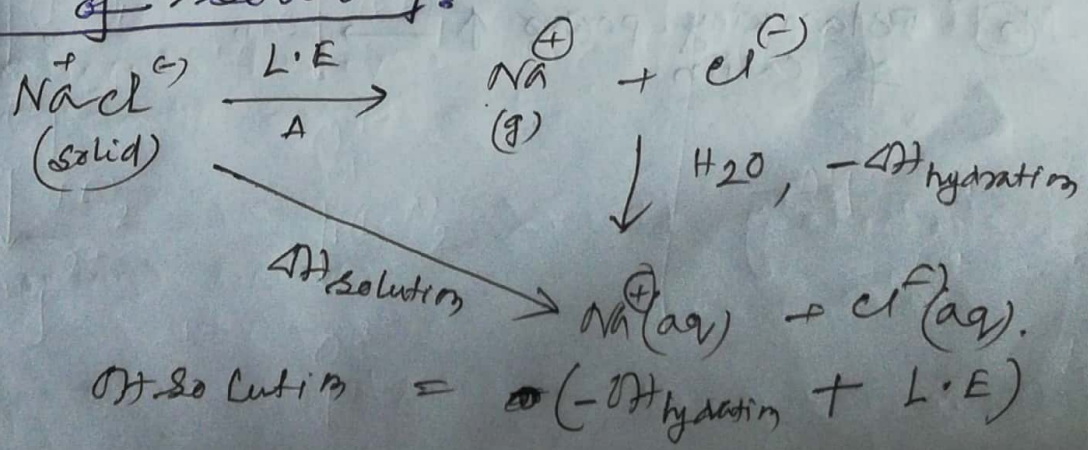
Amount of Energy or heat released to convert one mole gaseous ions to its aqueous ions is called Heat of hydration.



If hydration energy of any salt is greater than the lattice energy, salt easily get dissolved in water (solvent).

(Solubility of salt in solvent) \propto (Solvation energy - Lattice energy)

Heat of solution:-



Heat of Solution:

Energy exchanged to convert one mole of ~~any~~ molecule into its aqueous ions. It may be +ve or -ve.

\Rightarrow $L.E > \Delta H_{\text{hydration}}$ then +ve.

\Rightarrow $L.E < \Delta H_{\text{hydration}}$ then -ve.

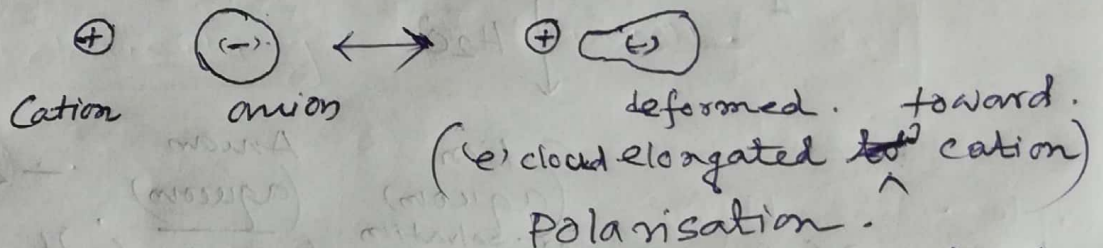
FAJAN'S RULE

Covalent character in ionic bond.

\downarrow qualitative idea.



Covalent character



(e) start to sharing \rightarrow covalent character

Polarisation of anion.

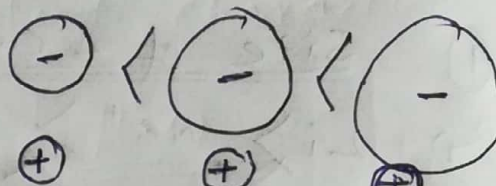
(Polarising power of cation.)

Rule:

- ① Polarisation \uparrow \rightarrow Covalent character \uparrow of anion.
- ② Polarising power \uparrow \rightarrow " " of cation.

Polarisability of Anions

① Size of anion $\rightarrow \uparrow \uparrow$



② Charge of anion $\rightarrow \uparrow \uparrow$

easily get distorted by cations.

Fajans rule:

in ionic bond.

① Covalent character increases with increasing of polarising power of cations.

② ~~Polarisability of anions~~. Covalent character increases in ionic bond with increase in Polarisability of anion.

~~Fajans~~

~~rule~~

(A)

Polarisation
(Polarisability)
or
Polarising power.

\propto Covalent nature in ionic bond.

(B)

Melting point \propto

Covalent character

~~Covalent bond is less stronger than ionic bond.~~

(C)

Solubility in

Covalent character

Water

*
Ionic compound \rightarrow Soluble in water (more)
Covalent " \rightarrow " " " (less)

Example 1

NaCl, KCl, RbCl.

Size: $Na^+ < K^+ < Rb^+$

Polarising power: $Na^+ > K^+ > Rb^+$

Covalent character: $NaCl > KCl > RbCl$

Solubility: $RbCl > KCl > NaCl$.

Melting point: $RbCl > KCl > NaCl$.

H.W $BeCl_2, MgCl_2, CaCl_2$

Example 2 NaCl, NaBr, NaI.

Size: $I > Br > Cl$.

Covalent character: $NaI > NaBr > NaCl$

Solubility \Rightarrow $NaCl > NaBr > NaI$.

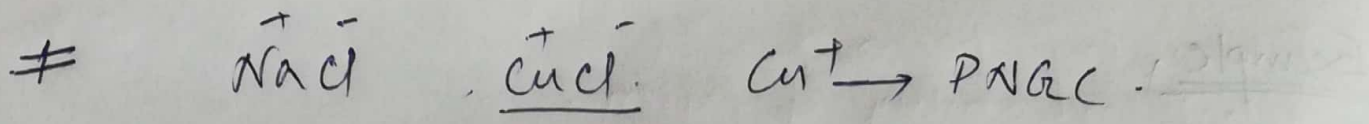
M. point \Rightarrow $NaCl > NaBr > NaI$

(*) ^{more} Covalent character \rightarrow more color imparting nature

Example 3 $BeF_2 < MgF_2$ (M. Point)

$CaCl_2, CaBr_2$ (M. point) \rightarrow ~~$CaBr_2$~~

Ans $CaCl_2 > CaBr_2$



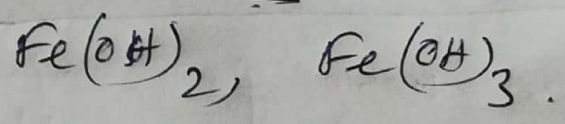
$\text{CuCl} > \text{NaCl}$ Covalent character.

M. point $\text{CuCl} < \text{NaCl}$.

Solubility: $\text{NaCl} > \text{CuCl}$.

H.W
Kd, Agel.
 M. point; Solubility in water.

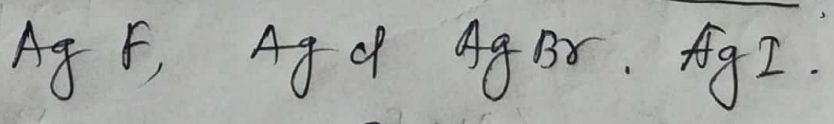
H.W
Solubility in water.



H.W $\text{Ag}_2\text{O}, \text{Ag}_2\text{S} \Rightarrow$ i) Solubility?
 ii) M. point?
 (iii) Covalent character?

$\text{CC} \uparrow \Rightarrow \text{M. Point} \downarrow \Rightarrow \text{Solubility} \downarrow \Rightarrow \text{Color impurity} \uparrow$

Which is more color intense.



Cation Same $\rightarrow \text{Ag}^+$

Size of anion $\text{I}^- > \text{Br}^- > \text{Cl}^- > \text{F}^-$

Polarisability $\Rightarrow \text{I}^- > \text{Br}^- > \text{Cl}^- > \text{F}^-$

Covalent character $\Rightarrow \text{AgI} > \text{AgBr} > \text{AgCl} > \text{AgF}$.

Color $\Rightarrow \text{AgI} > \text{AgBr} > \text{AgCl} > \text{AgF}$
 Dark Yellow > Yellow > white > Colorless