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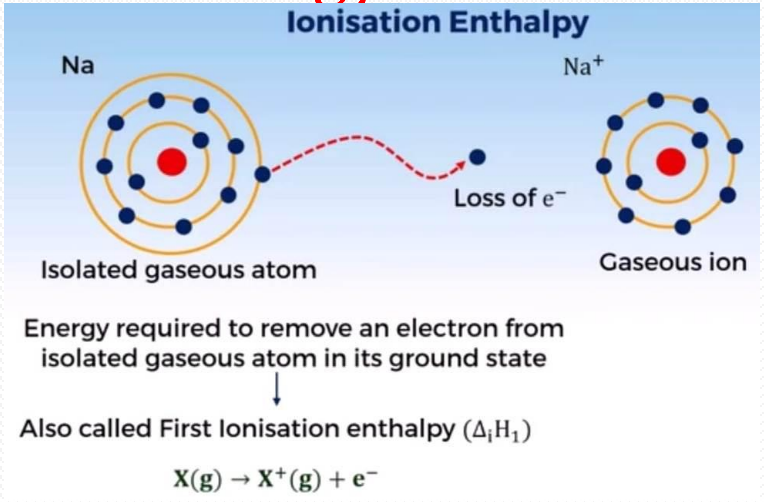
11TH APPEARING

Varun sir
M.Sc.(Chem.),SLET,M.Phil,B.Ed.

SHIVALIK SR.SEC.SCHOOL,BHARTHARI ROAD ,BEHROR MOB.01494-294297,9784067297

- Ionisation Potential or Ionisation Energy Ionisation Enthalpy:-



The minimum amount of energy required to remove the most loosely bonded electron from the outermost orbit of an isolated gaseous atom is called ionisation potential.

(isolated = without any bonding with other atom)

- Successive Ionisation Energy-

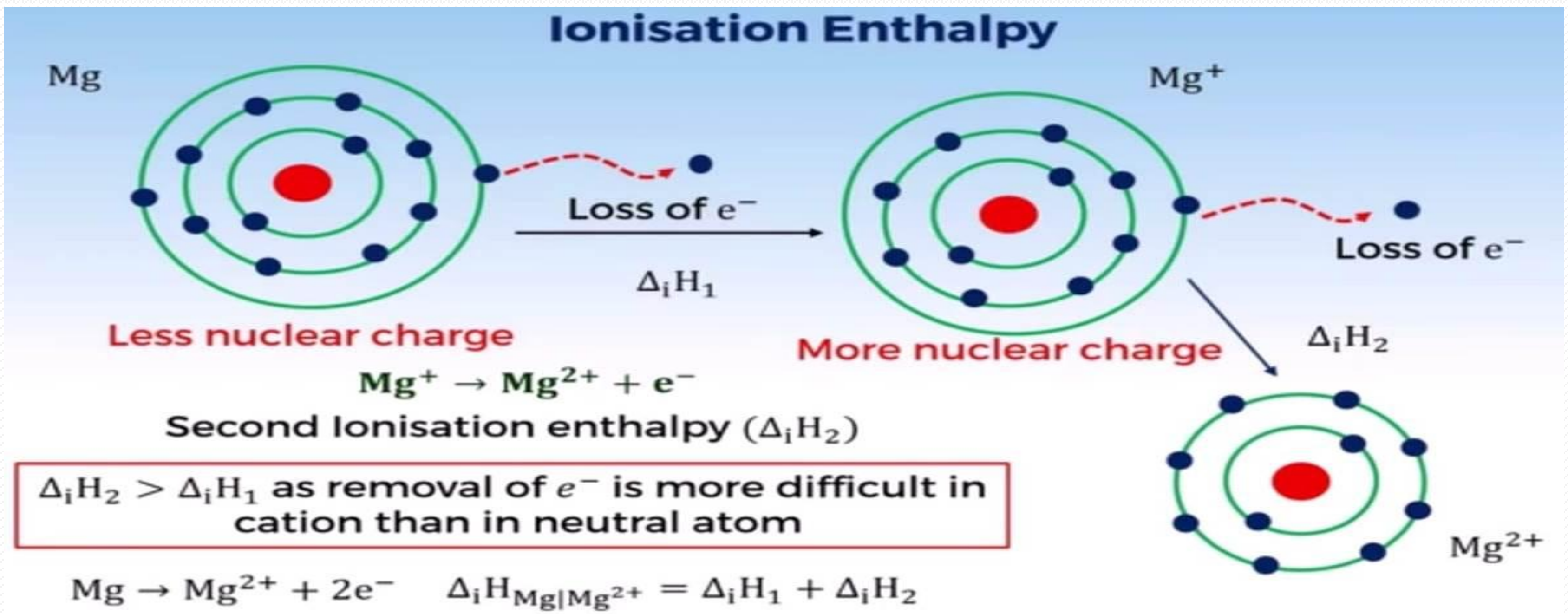
$M + E_1 \longrightarrow M^{+} + e^{-}$ E_1 = Ist I.P.

$M^{+1} + E_2 \longrightarrow M^{+2} + e^{-}$ E_1 = IInd I.P.

$M^{+2} + E_3 \longrightarrow M^{+3} + e^{-}$ E_1 = IIIrd I.P.

Increasing order of I.P.

Ist I.P. < IInd I.P. < IIIrd I.P. < ………………………………



- Note :- 1. Electron can not be removed from solid state of a atom.

  2. I.P. is always an endothermic process. ($\Delta H = +ve$)

  3. It is measured in ev/atom or kcal/mol or kJ/mol

1 ev/atom = 23.06 kcal/mol = 96.49 kJ/mol

Factors affecting Ionisation potential :-

1. Atomic size or radius :-

Larger the atomic size ,smaller is the ionisation potential . It is due to the size of atom increases the outermost electrons farther away from the nucleus and nucleus loses the attraction on that electrons and hence can be easily removed.

I.P. α ⅟size

- 2. Screening Effect :-

$$\text{I.P.} \;\alpha\; \frac{1}{\text{Screening Effect}}$$

3.Effective Nuclear charge :-

$$\text{I.P.} \;\alpha\; Z_{eff.}$$

4. Effect of stable electronic configuration :-

or Half filled and fully filled electronic configuration:

- According to hund's rule ,an atom has extra stability containing exactly half or full filled stability containing exactly haff or full filled electronic configuration. Hence for removal an electron from that atom need more energy than expected.

EX. I.P. of N > I.P. of O

$1S^2 2S^2 2P^3$ $1S^2 2S^2 2P^4$

EX. I.P. of P > I.P. of S

EX. $I.P._2$ of Cu > $I.P._2$ of Zn

EX. $I.P._2$ of Cr > $I.P._2$ of Mn

Note :- Highest I.P. of inert gas due to the completely filled electronic configuration .

I^{st} I.P. $Na < Al < Mg$ II^{nd} I.P. Mg^+ (2,8,1) $<$ Al^+ (2,8,2) $<$ Na^+ (2,8)

5. Penetration power of sub shells :-

Closeness of subshells to the nucleus is known as penetration effect.

For the subshell of same shell order of penetration effect is S > P > d > f

Penetration effect α I.P.

Due to higher penetration effect of S- orbital ionisation energy of corresponding elements of group 2 is higher than group 13.

ex. I.P. of Be ($1S^2 2S^2$) > I.P. of B($1S^2 2S^2 2P^1$)

EX. I.P. of Mg ($1S^2 2S^2 2P^6 3S^2$) > I.P. of Al($1S^2 2S^2 2P^6 3S^2 3P^1$)

6. Oxidation state of cation :-

> Oxidation state of cation α I.P.

$Fe^{+3} > Fe^{+2} > Fe$

* Periodicity of Ionisation Potential :-

L → R

Z_{eff} & I.P. ↑ & E.A ↑ & E.N. ↑

- Top ↓ Bottom

Z_{eff} = const. n ↑ & I.P. ↓ & E.A. ↓ & E.N. ↓

- Along a period Ionisation potential decreases.
- In a period alteration in the periodicity of I.P. occur due to penetration effect ,haff field and full field extra stability of subshell.

ex. I.P. of second period elements in KJ/mol are

Li	Be	B	C	N	O	F	Ne
500	900	800	1086	1403	1314	1681	2081

Li < B < Be < C < O < N < F < Ne

→ increasing order of I.P.

- In a group alteration in the periodicity of I.P. occur due to poor shielding effect and lanthanoide contraction of d & f electrons.

Ex. Al < Ga , In < Tl , Sn < Pb

- 5d – series element have higher ionisation energy than 4d-series elements due to lanthanoide contraction .

I.P. of Hf > I.P. of Zr

760 KJ/mol(5d) 674 KJ/mol (4d)

Application of Ionisation Potential :-

1. Metallic and Non metallic charcter :-

Metallic $\longrightarrow$ I.P. Low (Na ,K , Rb etc.)

Non metallic $\longrightarrow$ High I.P. (F, Cl,Br etc.)

I.P. α $\frac{1}{\text{metallic property}}$

- 2. Reactivity of metal :-

Reactivity of metal α 1/I.P.

3. Reducing charcter :-

Reducing charcter α 1/I.P.

* IA group has minimum ionisation potential so they are strong reducing agents in gaseous state.

Li < Na < K < Rb < Cs

* IA group in aqueous state

Li > K ≈ Rb > Cs > Na

As the degree of hydration is more in Li due to High charge density.

- 4. Stability of Oxidation states :-

(a) if the difference between two successive ionisation potential $\geq$ 16 ev then lower oxidation state is stable .

$Na \longrightarrow Na^{+} + e^{-}$ Ist I.P.

$Na^{+} \longrightarrow Na^{+2} + e^{-}$ IInd I.P.

42.7 ev

Difference of I.P. > 16 ev so Na^{+} is more stable.

(b) If the difference between two successive ionisation potential $\leq$ 11 ev than higher oxidation state is stable.

$Mg \longrightarrow Mg^{+} + e^{-}$ Ist I.P.

$Mg^{+} \longrightarrow Mg^{+2} + e^{-}$ II^{nd} I.P.

7.4 ev

Note :- Al^{+} is stable only in gaseous state . Al^{+3} is stable in liquid and solid state.