gradeup

Crack CSIR-NET 2021

(Study Notes on Ionization Energy)

Ionization energy

It is the amount of energy needed in order to remove the most loosely bound electron of the outermost shell (i.e., the outermost electron) from one mole of an isolated gaseous atom of an element in its ground state to produce a unipositive cation. $\underset{\substack{1\,\text{mole}\\ \text{G.S}}}{M_{(g)}} \rightarrow M^{+}{}_{(g)} + 1e^{-}; \Delta H = +x\,kj/mol$

Energy required to remove the first, second and third electron from the gaseous atom is called first, second and third ionization energy respectively.

$$M_{(g)} \xrightarrow{\text{I.E or I.E}_1\text{ of M}} M^{+}{}_{(g)} + 1e^{-} \rightarrow (1)$$

$$M^{+}{}_{(g)} \xrightarrow[\text{or I.E}_2\text{ of M}]{\text{I.E of M}^{+}} M^{2+}{}_{(g)} + 1e^{-} \rightarrow (2)$$

$$M^{2+}{}_{(g)} \xrightarrow[\text{or I.E}_3\text{ of M}]{\text{I.E of M}^{2+}} M^{3+}{}_{(g)} + 1e^{-} \rightarrow (3)$$

by adding eq 1, 2 & 3, we get

$$M_{(g)} \xrightarrow{(\text{I.E}_1 + \text{I.E}_2 + \text{I.E}_3)\text{ of M}} M^{3+}{}_{(g)} + 3e^{-}$$

Enthalpy of ionization is always endothermic process.

Factors affecting ionization Energy:

(i). **Atomic radius:** Ionisation potential $\alpha \dfrac{1}{\text{Atomic radius}}$

(ii). **Effective nuclear charge:** Greater the effective charge on the nucleus of an atom, more difficult would become to remove an electron from the atom. Ionisation Energy α Effective nuclear charge (Z_{eff})

(iii). **Penetration effect of orbitals:** The order of energy required to remove electron from s, p, d and f orbitals of a shell is:

s>p>d>f

(iv). **Shielding or screening effect:** Ionisation energy $\alpha \dfrac{1}{\text{Shielding effect}}$

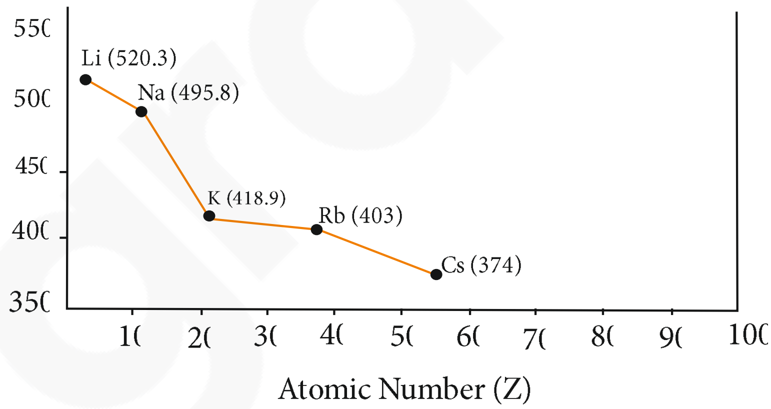
(v). **Stability of half-filled and fully filled orbitals:** According to Hund's rule, the stability of half-filled or completely filled degenerate orbitals is comparatively high. So, comparatively more energy is required to separate the electron from such atoms.

Periodicity in ionization potential: Generally, on going from left to right, ionization potential increases because of increase of effective nuclear charge. But this trend is always not. Whenever an element has half filed or fully filled configuration, its ionization energy will always be high. Example:

$$Be - 1s^2 2s^2$$
$$B - 1s^2 2s^2 2p^1$$

According to the general trend, ionization energy of B should be greater than Be but due to stable configuration of Be, its ionization energy will be higher than that of B.

Trend in I.E in groups of normal elements:



On moving from top to bottom in a group in transition series:

(a) In a group, the values of I.P. decreases because of increase in atomic size.

(b) In moving from second to third transition series, the value of I.P of second and third element almost become same due to lanthanoid contraction.

Applications of ionization potential:

(i). Along the period, ionization energy increases, so electropositive character decreases.

(ii) For noble gases, ionization energy is very high which makes them almost unreactive.

(iii) As the ionization energy of metal decreases, their reactivity increases.