CHEMISTRY

Ionic Bonding

Ionic Bond

The bond formed as a result of the electrostatic attraction between the positive and negative ions was termed the electrovalent or ionic bond.

- The electronic configuration of sodium atom (At. No. 11) is 2, 8, 1. It readily loses an electron as it is highly electropositive to attain the stable configuration of the nearest noble gas atom and becomes a positively charged sodium cation (Na^+).

  $Na \rightarrow Na^+ + 2e^-$ $\quad \Delta H = 493.8\ kJ/mol$

  (2, 8, 1) (2, 8) (Enthalpy Change)

- Chlorine atom (electronic configuration: 2, 8, 7) requires one electron to acquire the stable electronic arrangement of an argon atom. So, it becomes a negatively charged chloride anion (Cl^-).

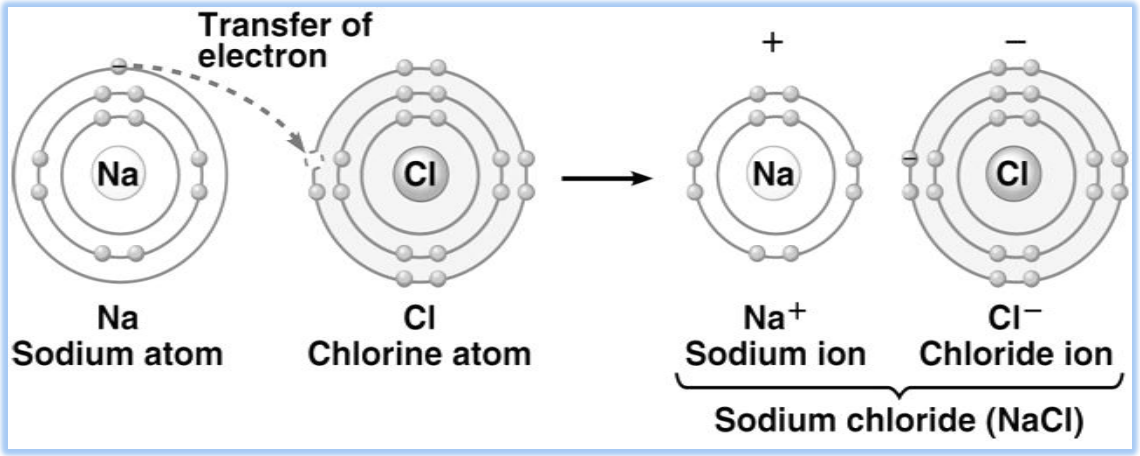
  $Cl + e^- \rightarrow 2Cl^-$ $\quad \Delta H = -379.5\ kJ/mol$

  (2, 8, 7) (2, 8, 8)

- According to Kossel's theory, there is a transfer of one electron from the sodium atom to the chlorine atom and both atoms attain the noble gas configuration.

  $Na + Cl \rightarrow Na^+ + Cl^-$

  (2, 8, 1) (2, 8, 7) (2, 8) (2, 8, 8)

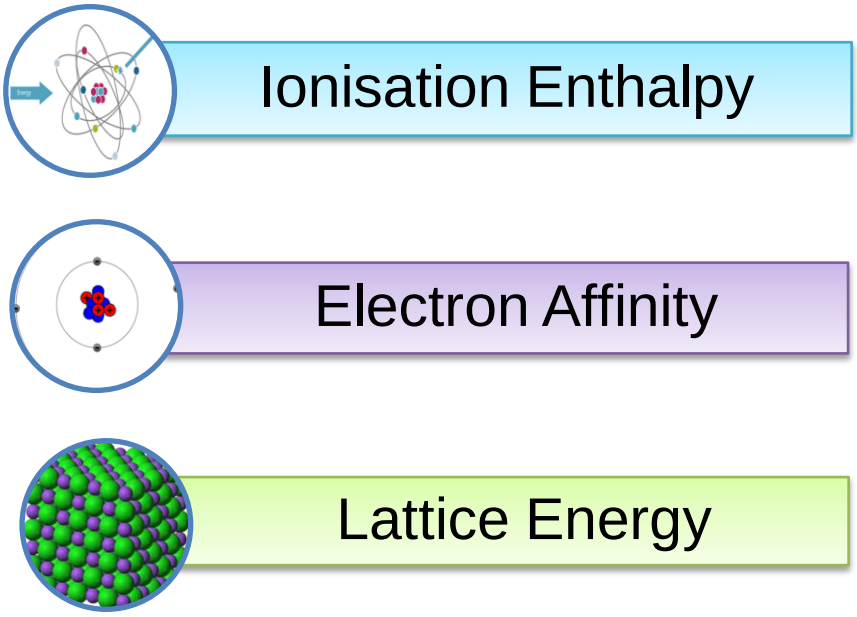


So, we can sum up that in an ionic bond,

- A metal atom and a non-metal atom are involved.
- The metal atom loses electron/electrons, and a non-metal atom accepts electron/electrons.
- A positively charged ion or cation is formed from a metal atom.
- A negatively charged ion or anion is formed from a non-metal atom because of the acceptance of electrons from metal atoms.

Conditions for the Formation of an Ionic Bond

The formation of ionic compounds would primarily depend on the ease of formation of the positive and negative ions from the respective neutral atoms and the arrangement of the positive and negative ions in the solid. This further depends on



Ionisation Energy

One of the two atoms which are involved in an ionic bond should have low ionisation energy, i.e. a smaller amount of energy is required to pull out an electron from its outer energy level. Lower the value of ionisation potential, greater will be the ease of formation of cations and hence the ionic bond.

$$M \xrightarrow{E_1} M^+ + e^- \ (E_1 = \text{First ionisation energy})$$
$$M^+ \xrightarrow{E_2} M^{2+} + e^- \ (E_2 = \text{Second ionisation energy})$$

In the periodic table, alkali metals have low ionisation energies. So, they can readily lose an electron from valence shells.

Electron Affinity

One of the two atoms which are involved in an ionic bond should have high electron affinity, i.e. it should be able to accept an electron in its outer energy level readily. Higher the electron affinity, greater will be the ease of formation of the anion.

$$X + e^- \rightarrow X^- + \text{Energy (Electron affinity)}$$
Atom Singly charged ion

$$X^- + e^- + \text{Energy supplied} \rightarrow X^{2-}$$
Singly charged ion

In the periodic table, Group VII (Halogens) possess the highest electron affinities of all the elements, because of this they are converted to anions by accepting electrons easily and form ionic bonds readily.

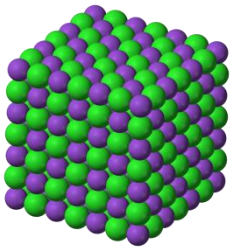
Lattice Enthalpy

The last parameter on which the formation of an ionic bond is dependent is lattice energy. The lattice enthalpy of an ionic solid is the energy required to completely separate one mole of a solid ionic compound into gaseous constituent ions. Higher the value of the lattice energy of ionic compounds, greater will be its ease of formation.

Characteristics of Ionic Compounds

Characteristics of electrovalent/ionic compounds:

- Ionic compounds consist of ions and not molecules. For example, sodium chloride is an electrovalent compound consisting of an equal number of sodium and chloride ions.
- Ionic compounds are hard crystalline solids. The crystal of sodium chloride has a definite shape. There is a strong electrostatic force of attraction, which holds the ions together.



- Ionic compounds have high melting and boiling points. For example, sodium chloride has a high melting point of 1472°F and boiling point of 2575.4°F.
- Electrovalent compounds or ionic compounds are usually soluble in water but insoluble in organic solvents such as ether, acetone, benzene, carbon disulphide and carbon tetrachloride. Ionic compounds dissolve in polar or ionic solvents.
- Ionic compounds conduct electricity when dissolved in water. They also conduct electricity when melted because of the formation of free mobile ions. They do not conduct electricity in the solid state. In the solid state, the ions are held together in fixed positions by the electrostatic forces of attraction. Therefore, the ions are not free.
- Ionic compounds have a high density. The oppositely charged ions in an ionic compound are held very closely by strong electrostatic forces of attraction, resulting in the number of ions per unit volume increase because of which the mass per unit volume of the compound increases.