CHEMICAL BONDING AND MOLECULAR STRUCTURE
IONIC OR ELECTROVALENT BOND

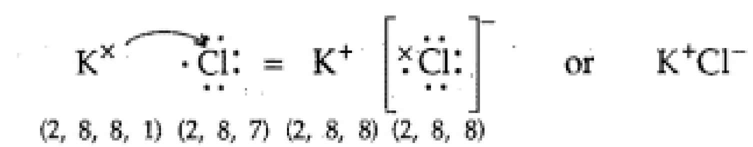
❖ ELECTROVALENT OR IONIC BOND

The chemical bond formed between two or more atoms as a result of the transfer of one or more electrons from electropositive to electronegative atom is called electrovalent bond. This bond is also called ionic or polar bond. The electron transfer results in the formation of cations and anions. The cations are positively charged ions whereas anions are negatively charged ions. Oppositely charged ions are attracted to each other and a bond between them is formed. The bond existing between the oppositely charged ions is called an ionic or electrovalent or polar bond or the bond formed by the electrostatic attraction between positive and negative ions is called an ionic bond. Compounds containing ionic bonds are called ionic, electrovalent or polar compounds.

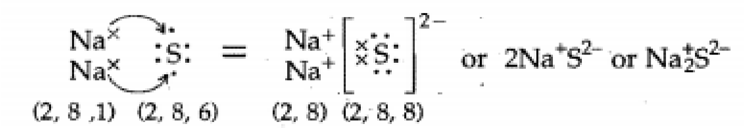
[**Note:** Electrovalent bond is not possible between similar atoms. This type of bonding requires two atoms of different nature, one atom should have the tendency to lose electron or electrons, i.e., electropositive in nature and the other atom should have the tendency to accept electron or electrons, i.e., electronegative in nature. Actually, ionic bond is not a true bond but just electrostatic attraction between closely packed ions. It is non directional in nature.]

Examples of Electrovalent Bond

(i) Potassium chloride: The free potassium atom has one valency electron (electronic configuration 2, 8, 8, I), i.e., 4s1whereas, the chlorine atom has seven valency electrons (electronic configuration 2, 8, 7), i.e., 3s2 3p5. In forming an ionic bond, the potassium atom loses its valency electron which is accepted by chlorine atom. As a result, potassium achieves noble gas configuration of argon (2, 8, 8) and becomes a positive ion· (K+). Chlorine achieves noble· gas configuration of argon (2, 8, 8) and acquires a negative charge (Cn. The attraction between potassium ion and chloride ion is an ionic bond. A shorthand way of showing the formation of potassium chloride from potassium and chlorine atoms involves electron dot symbols.



(ii) Sodium sulphide: Sodium combines with sulphur to form sodium sulphide, Na2S, two sodium atoms, each loses its valency electron, are converted into sodium ions with neon like configuration (2, 8). Sulphur (2, 8, 6) which has six electrons in the valency shell gains two electrons to achieve the argon like configuration (2, 8, 8).



Conditions for Forming Electrovalent or Ionic Bond

The following conditions favor the formation of an electrovalent bond.

(i) Number of valency electrons: One atom should possess I, 2 or 3 valency electrons while the other atom should have 5, 6 or 7 valency electrons. The atom which changes into cation should possess 1,2 or 3 valency electrons, i:e., it should belong to group IA, IIA or IlIA. It should be metallic or electropositive in nature. The other atom which changes into anion should possess 5, 6 or 7 electrons in the valency shell, i.e., it should belong to group VA, VIA or VIlA. It should be non-metallic or electronegative in nature. The atoms of transition metals can also lose electron or electrons and converted into cations. Thus, they can also form electrovalent bonds but do not acquire inert gas configuration always.

(ii) Difference in electronegativity: The formation of an electrovalent bond will be easier if the difference in the electronegativities' of the two atoms is high. A difference of about 2 is necessary for the formation of an electrovalent bond. The electronegativity of sodium is 0.9 and that of fluorine is 4.0. Since the difference is 3.1 both will readily form an electrovalent bond.

(iii) Overall decrease in energy: In the formation of an electrovalent bond, there must be overall decrease in energy, i.e., energy must be released. Energy changes are involved in the following steps:

(a) Energy equivalent to ionisation energy is required to convert a neutral isolated gaseous atom into a cation.

$$A + \text{ionisation energy} = A^{+} + e^{-} \qquad \ldots\ldots\ldots\text{(i)}$$

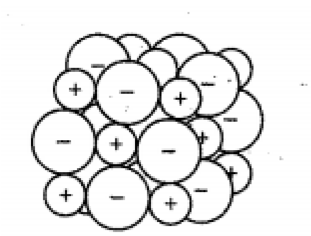
Lower the value of ionisation energy of an atom, greater will be the ease of formation of the cation from it, i.e., one atom should have low value of i ionisation energy.

(b) Energy equivalent to electron affinity is released when an electron is added to a neutral isolated gaseous atom to make it univalent anion.

$$B + e^{-} = B^{-} + \text{electron} \qquad \ldots\ldots\text{(ii)}$$

Higher the value of electron affinity of the atom, greater the ease of formation of the anion from it, i.e., other atom should have high value of el~ctron affinity.

(c) Lattice energy: Cation and anion attract each other, by electrostatic force of attraction to give a molecule A^+B^-.



Crystals of ionic compounds Since the electrostatic field of a charged particle extends in all directions, a positive ion is surrounded by a number of negatively charged' ions while each negative ion similarly surrounded by a number of positive ions. These cations. And anions arrange systematically in an alternating cation-anion pattern. This is called a crystal lattice. This process of clustering ions increases the force of attraction and thus potential energy decreases. The energy released when the requisite number of positive and negative ions are condensed into crystal to form one mole of the compound is called lattice energy (III step). Higher the lattice energy, greater will be the ease of forming an ionic compound.

Properties of Ionic or Electrovalent bond

(i) An ionic bond is purely electrostatic in nature.

(ii) Its formation is favored by:

(a) Low ionisation potential (I.P;) of the element that forms a cation on losing electron(s). The element should be metal, i.e., electropositive in nature.

(b) High electron affinity (E.A.) of the element that forms an anion on gaining electron(s). The element should be non-metal, i.e., electronegative in nature.

(iii) (c) High lattice energy (L.E.) :. The energy released when isolated ions form· a crystal. The value of lattice energy depends on the charges present on the two ions and distance between them. It shall be high if charges are high and ionic radii are small.

(d) The summation of three energies should be negative, i.e., energy is released.

I.P. + E.A. + L.E .= -ive

(iv) Highly electropositive elements of groups I and II combine with highly electronegative elements of VI and VII (or 16th and 17th) groups to form electrovalent or ionic compounds. Halides, oxides, sulphides, nitrides and hydrides of alkali and alkaline earth metals are generally ionic.

(v) Greater the difference of electronegativity between two atoms, higher will be the possibility of ionic bond formation.

(vi) **Electro-valency:** The capacity of an element to form electrovalent or ionic bond is termed as electro valency. The capacity is measured in terms of the electrons lost or accepted. Thus, electrovalence of an element is equal to the number of electrons lost by an atom of the element or gained by the atom of the element as to acquire inert gas configuration. The elements which lose electron or electrons.

(vii) show positive electro valency and the elements which gain electron or electrons show negative electro valency. Generally, positive and negative signs are not used in practice and only the number is taken to represent electrovalence.

Element	No: of ele-ctrons lost or gained by an atom	Electro-valency	Change in electronic configuration
Na	1 (lost)	1 (Monovalent)	2,8,1 to 2,8 (Na^{+})
K	1 (lost)	1 (Monovalent)	2,8,8,1 to 2,8,8 (K^{+})
Mg	2 (lost)	2 (Divalent)	2,8,2 to 2,8 (Mg^{++})
Ca	2 (lost)	2 (Divalent)	2,8,8,2 to 2,8,8 (Ca^{++})
Al	3 (lost)	3 (Trivalent)	2,8,3 to 2,8 $(A1^{+++})$
F	1 (gained)	1 (Monovalent)	2,7 to 2,8 (F^{-})
Cl	1 (gained)	1 (Monovalent)	2,8,7 to 2,8,8 (Cl^{-})
O	2 (gained)	2 (Divalent)	2,6 to 2,8 (O^{-7})
S	2 (gained)	2 (Divalent)	2,8,6 to 2,8,8 (S^{-})
N	3 (gained)	3 (Trivalent)	2,5 to 2.8 $(N^{-\cdots-})$