CHAPTER 2
CHEMICAL BONDING

- **Atom:** Smallest particle of an element which can enter into chemical combination.

  Example: O-atom, N-atom, H-atom etc.

- **Molecule:** Smallest particle of an element or a compound capable of independent existence.

  Example: O_2, N_2, H_2 etc. Molecule may be molecule of an element or molecule of a Compound.

- **Chemical Bond:** A chemical bond is the attractive force which holds together combining atoms in a molecule.

Attainment of a stable electronic configuration:

- Atoms of most elements combine to form molecules.
- Atoms of noble gases do not normally react with any other atoms and are monoatomic.
- Atoms of noble gases are extremely stable and their energy cannot be further minimized.
- They have a completely filled stable outer shell configuration.

Table 1: Electronic configuration of noble gas atoms

Elements	Atomic number	Number of electrons in various shells						Valance electrons
		K	L	M	N	O	P	
Helium	2	2						2
Neon	10	2	8					8
Argon	18	2	8	8				8
Krypton	36	2	8	18	8			8
Xenon	54	2	8	18	18	8		8
Radon	86	2	8	18	32	18	8	8

Atoms having two electrons (2 in case of K-shell) and 8 electrons in the outermost shells are very stable and un-reactive.

Octet State : Stable state of having eight electrons in the outermost shell of an atom.
Duplet State : Stable state of having two electrons in the outermost shell of an atom.
Octet rule : The principle of attaining a maximum of eight electrons in the outermost valence shell of an atom.

Duplet Or Diad Rule: The principle of attaining a maximum of 2 electrons in the outermost valence shell of an atom.

Electronic theory of valency (1916): Developed by Kossel and Lewis. The theory states that atoms combine to acquire the nearest noble gas electronic configuration by losing, gaining or sharing electrons.

Types of Chemical Bond

(1) Electrovalent or ionic bond
(2) Covalent bond
(3) Co-ordinate bond

1. **Electrovalent/Ionic Bond:** A chemical bond formed by direct transfer of valence electron(s) in which oppositely charged ions are held together by strong electrostatic force of attraction.

- The number of electrons lost or gained by an atom in the formation of an electrovalent bond is termed as **electrovalency.**
- Electrovalent or ionic bond is formed between a metal and a non-metal.

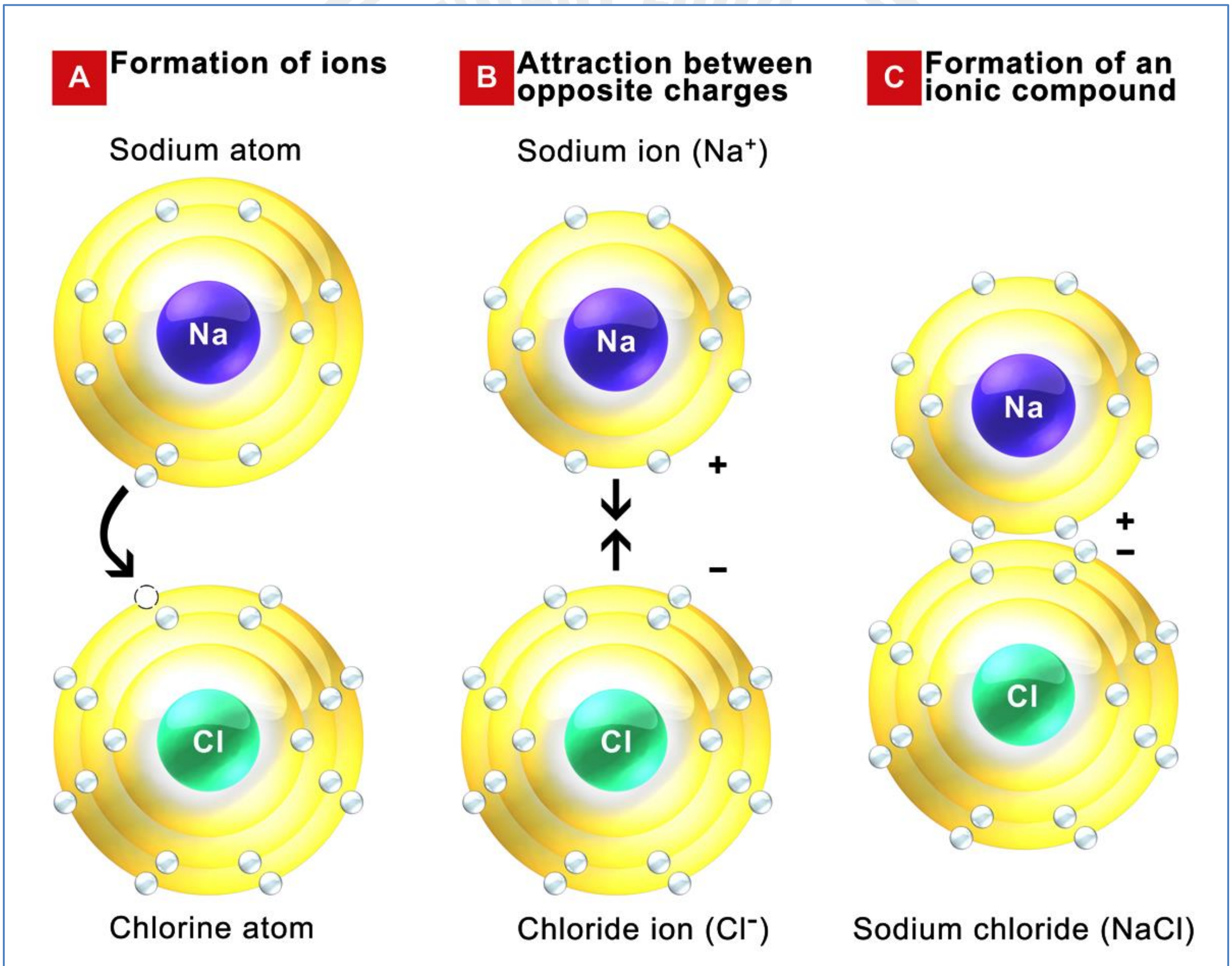
Example: Formation of Sodium Chloride

$Na \longrightarrow Na^{+} + e^{-}$

$Cl + e^{-} \longrightarrow Cl^{-}$

$Na^{+} + Cl^{-} \longrightarrow Na^{+}Cl^{-}$ or $NaCl$

$Na^{+} + Cl^{-} \rightarrow NaCl$



Formation of an Ionic Bond

- Electrovalence of Na and Cl atoms is 1 each.
- Electrovalent/Ionic Compound: Compounds formed as a result of electrovalent bonding.

Characteristics of Ionic compounds:

(a) Exists as crystalline solids in which oppositely charged ions attract one another strongly forming regular crystal structure.
Example: In NaCl crystal, each Na^+ ion is surrounded by six Cl^- ion and each Cl^- ion is surrounded by six Na^+ ions.

(b) Ionic compounds have high melting and high boiling points due to strong electrostatic force of attraction between the oppositely charged ions resulting in high melting and boiling points.

(c) They conduct electricity in molten state and aqueous solutions due to the presence of free ions.

(d) They are usually soluble in water and other polar solvents as the polar water molecules have strong attraction for free ions in solution.

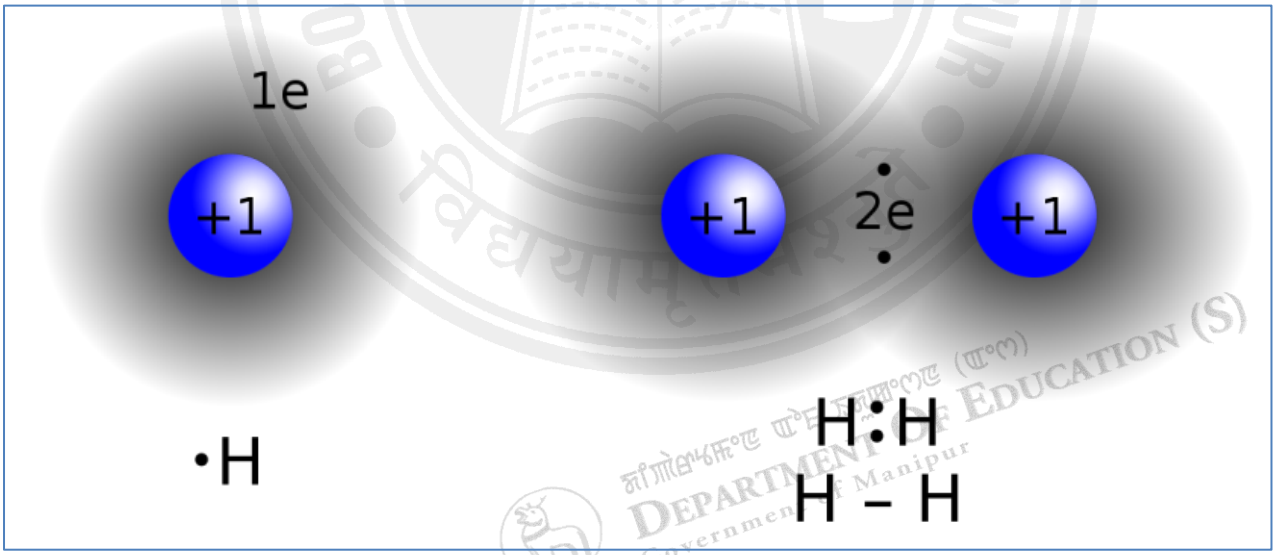
2. Covalent Bond: Chemical bond formed by mutual sharing of electrons between the combining atoms. Covalent bond may be single, double and triple bond. It is formed between non-metals.

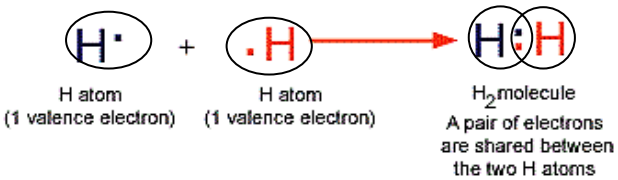
➢ **Types of Covalent Bond:**

(a) **Single Covalent bond (-):** formed by sharing of one pair of electron.

e.g. - (1) Formation of hydrogen molecule

Hydrogen has only one electron that is confined in K- shell. When two hydrogen atoms approach each other, a hydrogen molecule is formed but having a shared pair of valance electrons. The two hydrogen nuclei are bound together by a single covalent bond and each hydrogen atom attains the nearest helium configuration.





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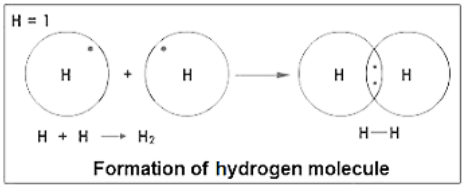


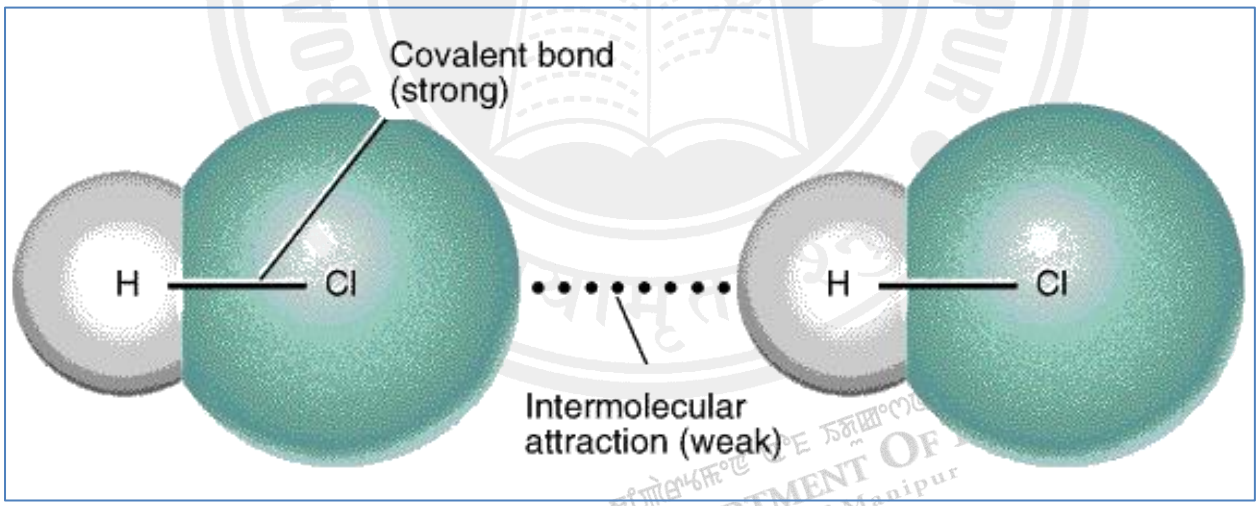
Fig. Formation of Hydrogen molecule

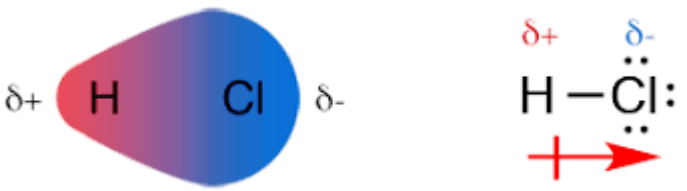
(2) Formation of Hydrogen Chloride (HCl) molecule

Hydrogen has one electron and chloride has seven electrons in the valence shell. Then by mutual sharing between H and Cl, H attains the duplet configuration and chlorine attains octet configuration. But the shared electron pair is more strongly attracted by Cl atom due to having more electronegativity that leads to the development of partial opposite charges to them and make the covalent bond to be polar i.e.

Is HCl polar or non-polar?

HCl is polarity due to unequal sharing of valence electrons and gives partial charges on atoms. It is because of the difference in electronegativity between Hydrogen and Chlorine.





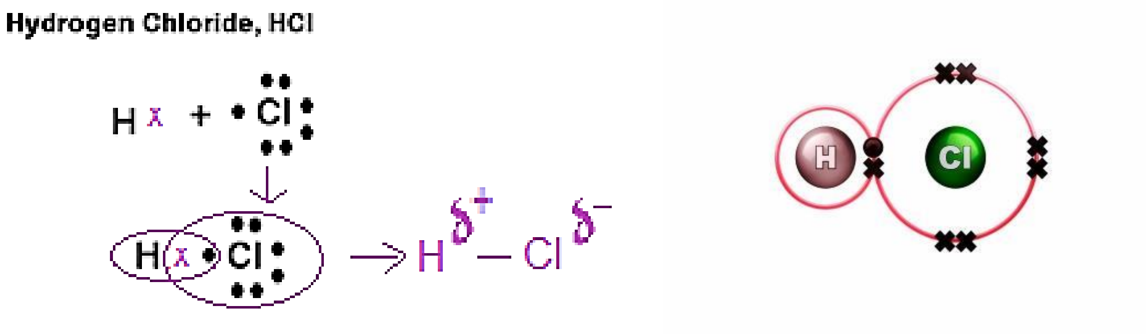
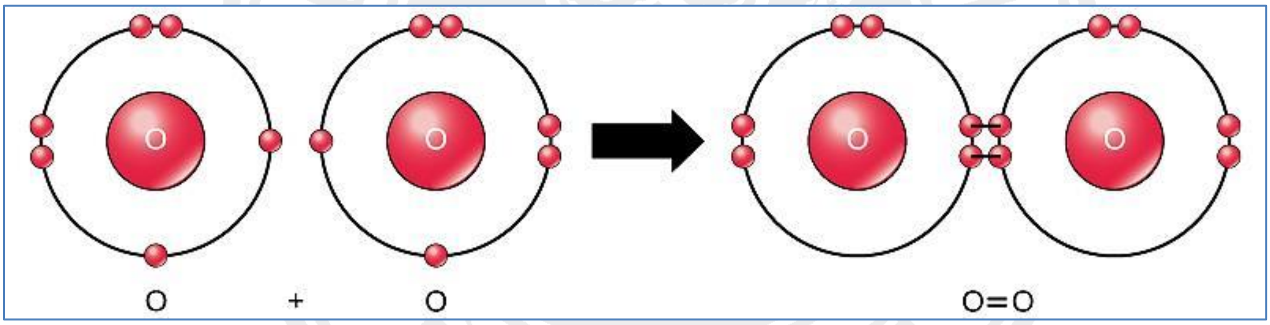


Fig. Formation of HCl

- **Double Covalent bond (=):** formed by sharing of two pair of electrons.
  Example: Formation of Oxygen molecule O_2
  Each oxygen (O) atom has six electrons in the valence shell and requires two electrons to form an octet. Both the oxygen atoms share two electrons resulting in double bond.



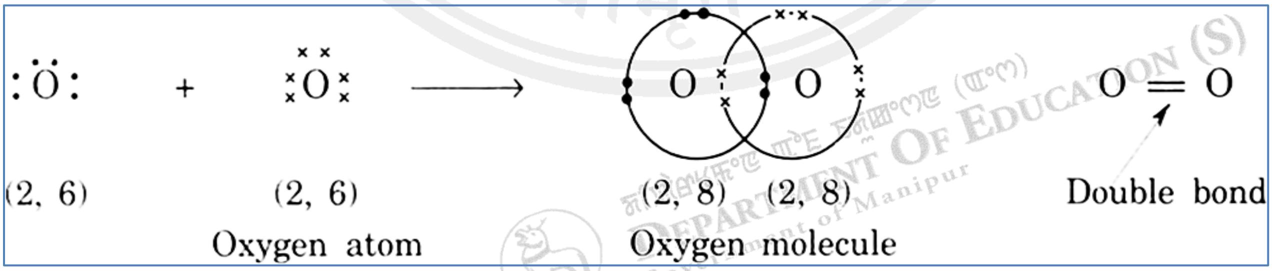
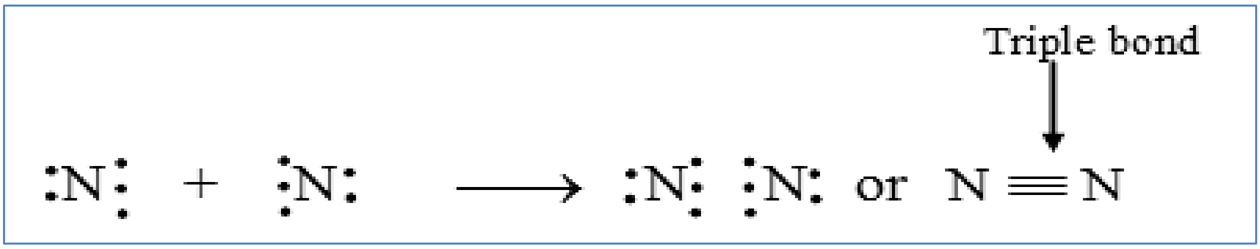
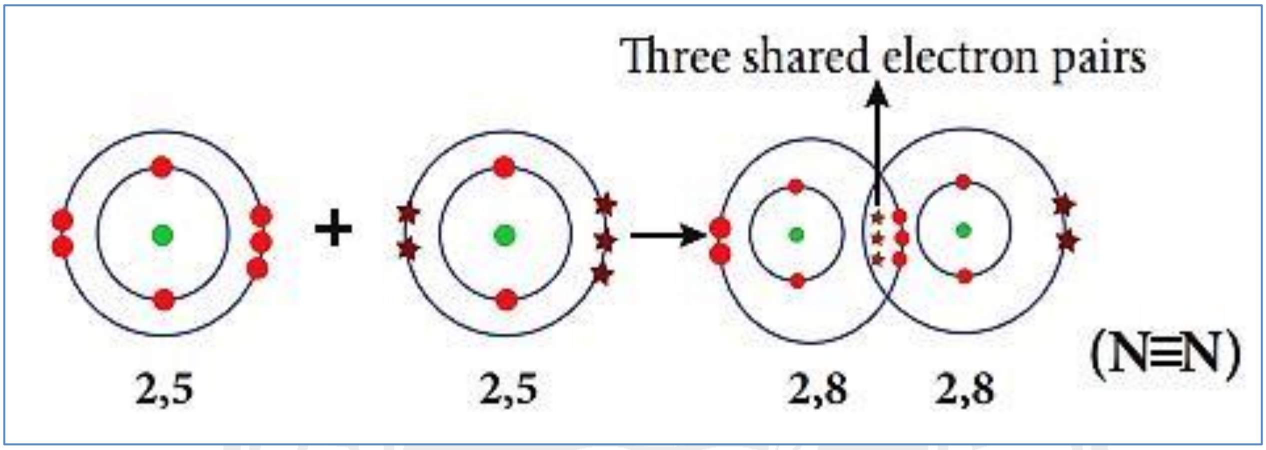


Fig. Formation of oxygen molecule

- **Triple Covalent bond (≡):** formed by sharing of three pair of electrons.

  Example: **Formation of Nitrogen molecule**





- **Covalency:** Number of electrons shared by a combining atom in the formation of a Covalent bond.

  Example: In N_2 molecule, covalency of N-atom is **3.**

- **Covalent Compound:** Compounds formed as a result of covalent bonding.

Properties of covalent compounds:

a) Generally exists as liquids or gases at room temperature
b) They have low melting and boiling points.
c) They have low densities.
d) They are sparingly soluble in water, but soluble in non-polar organic solvents.
e) They do not conduct electricity.

Electronegativity:

Electro-negativity is defined as the relative tendency of an atom to attract shared electron pair to itself when combined in a compound.

Polar covalent bond: A covalent bond having a di-polar character is called **polar covalent bond.**
Polar covalent compound: Compound formed by polar covalent bond.
Example: Formation of Hydrogen chloride molecule (HCl)
In HCl, there is unequal sharing of a pair of electron between Hydrogen & Chlorine atom. Of the two nuclei, chlorine has more electronegativity compared to hydrogen and hence the chlorine nucleus exerts more attraction to the shared electron pair than the hydrogen nucleus. So, Chlorine end will be **partially negative (δ^-)** and hydrogen end will be **slightly positive (δ^+). The unsymmetrical distributed charge on the HCl molecule produces a permanent dipole.**

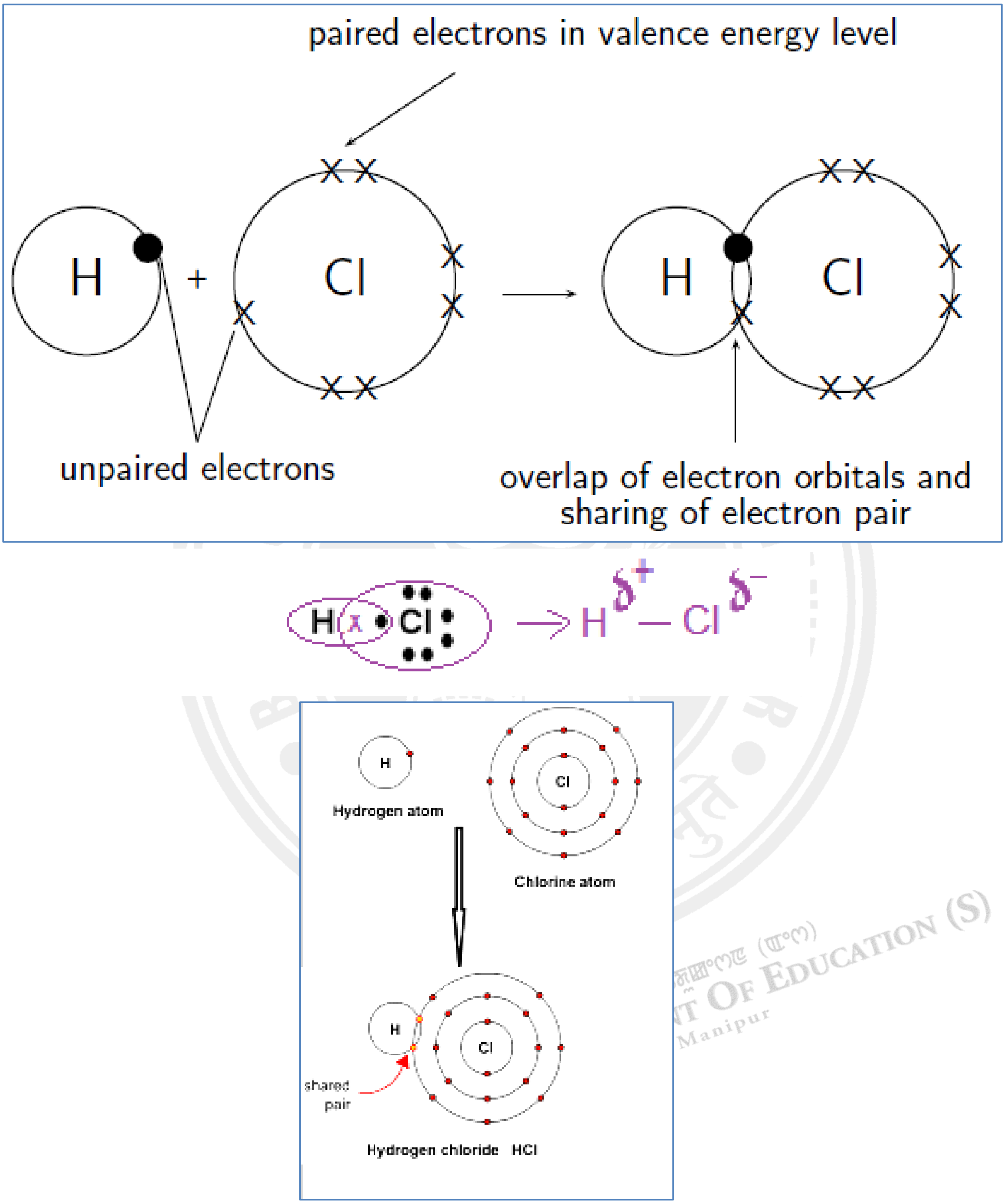


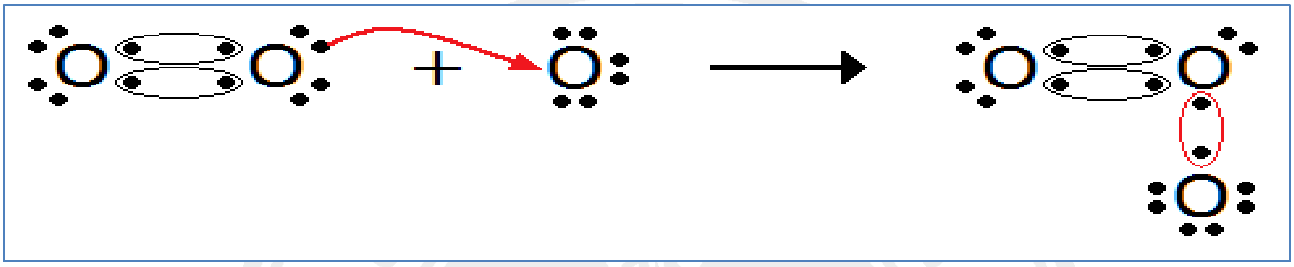
Fig. Formation of Hydrogen chloride molecule

- **Lone pair of electrons (l.ps):** Electron pair not taking part in bond formation.
- **Bond pair of Electrons (b.ps):** Electron pair taking part in bond formation.

Co-ordinate Bond or Dative Bond: A chemical bond formed by the one sided sharing of valence electron(s) from certain atoms which have already attained their stable state to another electron deficient atom.

It is also called co-ordinate covalent bond or dative bond.

Example: Formation of Ozone molecule



Formation Of Ozone layer

- The ozone layer or ozone forms by conversion of atmospheric oxygen(O_2) into ozone (O_3), this process is called as "**Chapman Cycle**"

- The oxygen get photolyzed by U.V.rays to form oxygen radical.

- The oxygen radical then react with molecular oxygen and forms ozone molecule.

- At the same time ozone gets reduce to oxygen by reacting with oxygen radical.

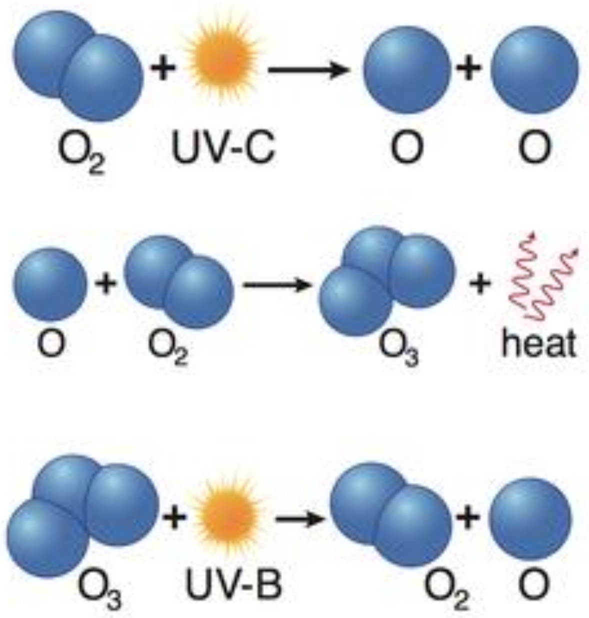


Fig. Formation of Ozone

Bonding in metals:

To account for the bonding in metals, **Lorentz** has proposed a model known as **electron sea model.** According to this model, a metal lattice consists of positively charged kernels arranged in a regular way surrounded by loosely held valence electrons.

Kernels are metal nuclei and other electrons except valence electrons.

Metallic bond: The simultaneous force of attraction between the positively charged kernel and the mobile electrons which binds the metal atoms together.

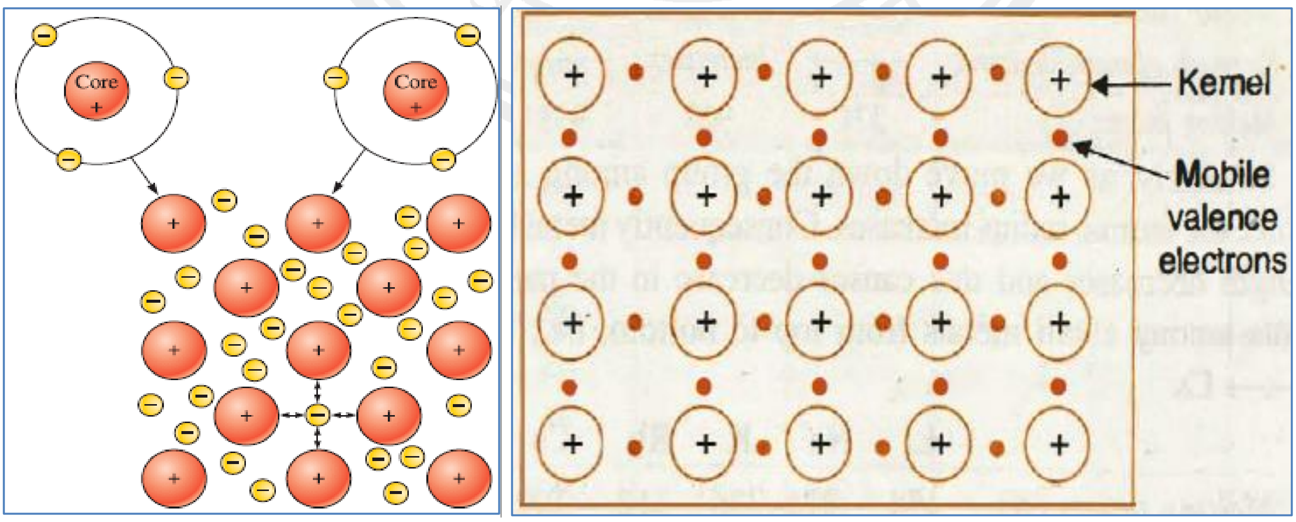


Fig. Electron sea model of metal

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