

Chemical Bonding

Chemical Bond: A chemical bond is the physical phenomenon of chemical substances being held together by attraction of atoms to each other through sharing, as well as exchanging, of electrons or electrostatic forces.

Bond Enthalpy: The energy required to break a bond or the energy released during the bond formation is called the bond enthalpy.

Classification: There are three major types of chemical bond. They are-

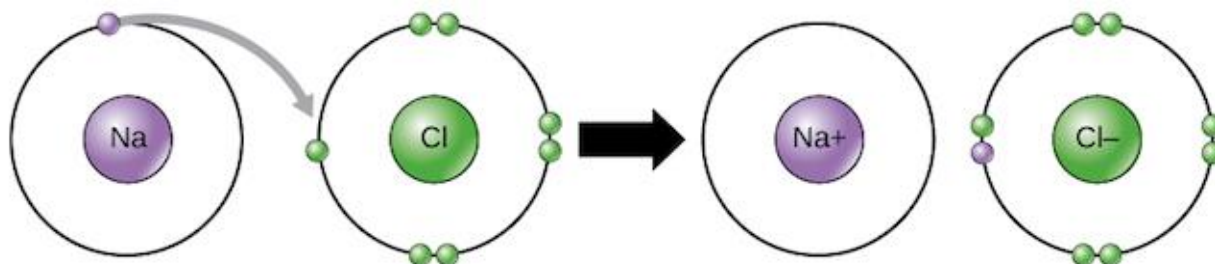
- i. Ionic Bond
 - ii. Covalent Bond
 - iii. Metallic Bond
- i. **Ionic Bond:** Ionic bonding is a type of chemical bonding that involves the electrostatic attraction between oppositely charged ions.

In ionic bonds, the metal loses electrons to become a positively charged cation, whereas the nonmetal accepts those electrons to become a negatively charged anion.

Sodium and chlorine atoms provide a good example of electron transfer.

Sodium (Na) only has one electron in its outer electron shell, so it is easier for sodium to donate that one electron than to find seven more electrons to fill the outer shell. Because of this, sodium tends to lose its one electron, forming Na^+ .

Chlorine (Cl), on the other hand, has seven electrons in its outer shell. In this case, it is easier for chlorine to gain one electron than to lose seven, so it tends to take on an electron and become Cl^- .

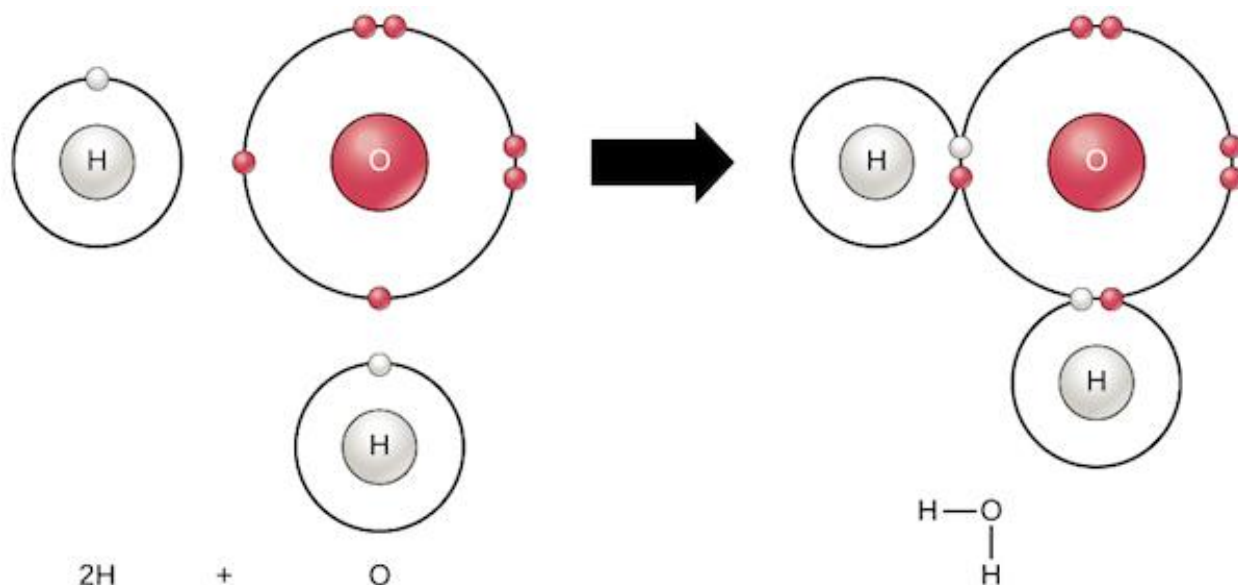


When sodium and chlorine are combined, sodium will donate its one electron to empty its shell, and chlorine will accept that electron to fill its shell. Both ions now satisfy the octet rule and have complete outermost shells. Because the number of electrons is no longer equal to the number of protons, each atom is now an ion and has a +1 (Na^+) or -1 (Cl^-) charge.

- ii. **Covalent Bond:** A covalent bond involves the sharing of electron pairs between atoms. These electron pairs are known as shared pairs or bonding pairs.

Hydrogen and oxygen atoms provide a good example of electron sharing.

A single water molecule, H_2O , consists of two hydrogen atoms bonded to one oxygen atom. Each hydrogen shares an electron with oxygen, and oxygen shares one of its electrons with each hydrogen:



The shared electrons split their time between the valence shells of the hydrogen and oxygen atoms, giving each atom something resembling a complete valence shell (two electrons for H, eight for O). This makes a water molecule much more stable than its component atoms would have been on their own.

There are two types of covalent bond. They are-

- Nonpolar bond
 - Electrons shared evenly in the bond
 - Electronegativity difference is zero
 - Example: Cl_2 , O_2 , H_2 etc.
- Polar Bond
 - Electrons unevenly shared
 - Electronegativity difference greater than zero but less than 2.0
 - Example: HCl , H_2O , NH_3 etc.

iii. Metallic Bond: The chemical bonding that results from the attraction between metal cations and the surrounding sea of electrons is called the metallic bond.

Properties of Metallic Bond:

- Vacant p and d orbitals in metal's outer energy levels overlap, and allow outer electrons to move freely throughout the metal

- Valence electrons do not belong to any one atom
- Metals are good conductors of heat and electricity
- Metals are malleable
- Metals are ductile
- Metals have high tensile strength
- Metals have luster

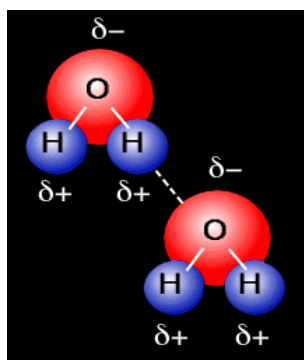
Polarization: If the cation is small and/or anion is large and/or they are highly charged, cation will distort the electron cloud of the anion, an effect summarized in Fajans' rules is called polarization.

Fajans Rule: Polarization will be increased by:

1. Smaller size of cation
2. Larger size of anion
3. Higher charge on cation and anion
4. Presence of electron in incomplete d and f subshell

Some Other Important Bonds-

- ❖ **Hydrogen Bond:** In a polar covalent bond containing hydrogen, the hydrogen will have a slight positive charge because the bond electrons are pulled more strongly toward the other element. Because of this slight positive charge, the hydrogen will be attracted to any neighboring negative charges. This interaction is called a hydrogen bond.



- ❖ **Van Der Waals Bond:** Non-polar molecules can exist in liquid and solid phases because van der Waals forces keep the molecules attracted to each other. Exist between CO_2 , CH_4 , CCl_4 , CF_4 , diatomics and monoatomics.