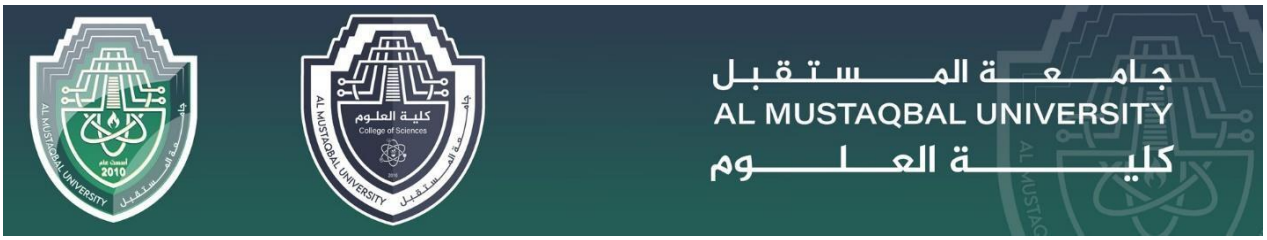

Analytical Chemistry

1st stage

Asst. Lect.Zahraa Hazim Hamid

Lecture 4: Chemical Bonding

Department of Medical Biotechnology

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1.1 Chemical Bonds

Chemical bonds hold molecules together and create temporary connections that are essential to life. Types of chemical bonds including covalent, ionic, and hydrogen bonds and London dispersion forces.

The type of chemical bonds formed varies in strength and properties. There are 4 primary types of chemical bonds which are formed by atoms or molecules to yield compounds. These types of chemical bonds include

- Ionic Bonds
- Covalent Bonds
- Hydrogen Bonds
- metallic Bonds

These types of bonds in chemical bonding are formed from the loss, gain or sharing of electrons between two atoms/molecules.

1.1.1 Ionic Bonds

Occurs when positively charged ions and negatively charged ions combine to form a molecule with a neutral electrical charge. An example of an ionic bond is sodium chloride (NaCl), commonly known as table salt.

Sodium (Na), with an atomic number of 11, has 11 electrons arranged in its electronic orbitals as follows: $1s^2,2s^2,2p^6,3s^1$

Chlorine (Cl), with an atomic number of 17, has 17 electrons arranged as $1s2,2s^2,2p^6,3s^2,3p^5$

In this bond, sodium donates its one outermost electron from the 3s orbital to chlorine, completing chlorine's outer shell. This transfer creates a positively charged sodium ion (Na^+) and a negatively charged chloride ion (Cl^-), which are held together by the electrostatic force of attraction, forming NaCl.

$_{11}Na$: $1s^2\ 2s^2\ 2p^6\ 3s^1$

$_{17}Cl$: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$

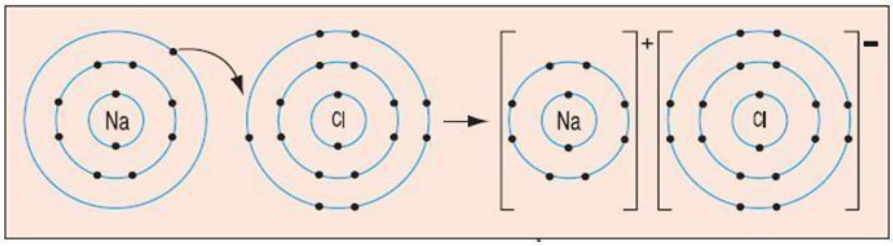
$Na \longrightarrow Na^+ + 1e^-$

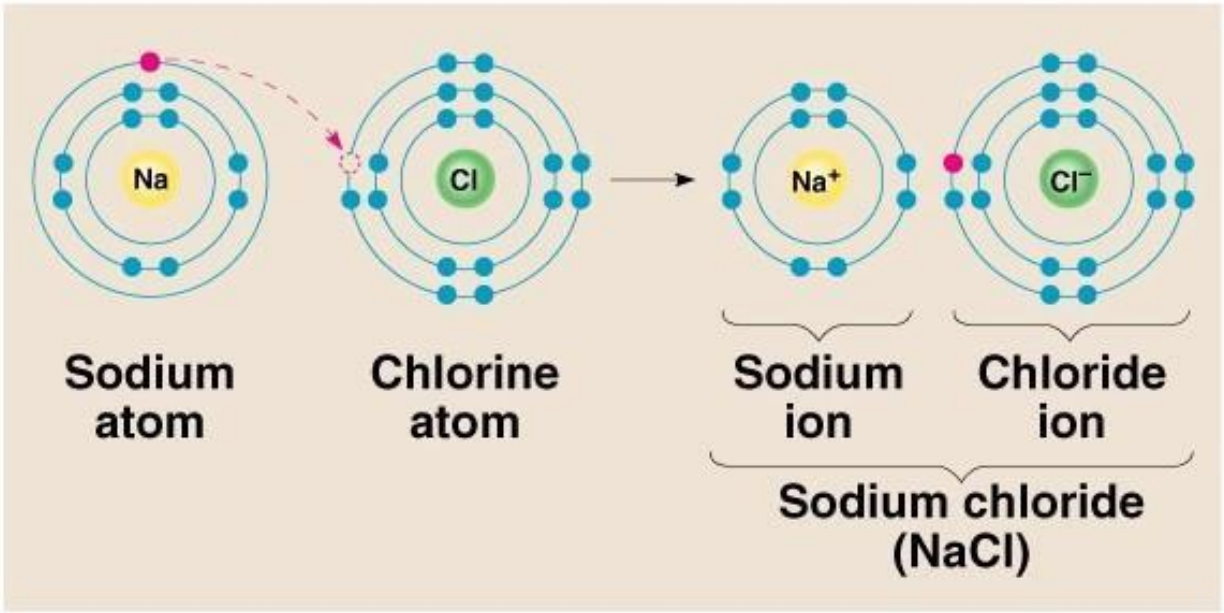
$Cl + 1e^- \longrightarrow Cl^-$

$Na + Cl \longrightarrow Na^+ Cl^-$

Na^+ : $1s^2\ 2s^2\ 2p^6$

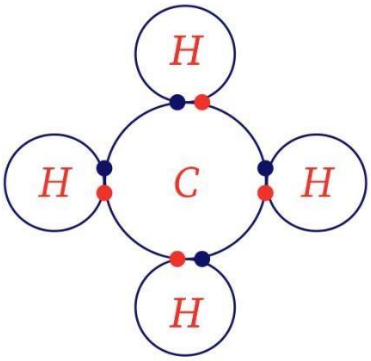
Cl^- : $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$

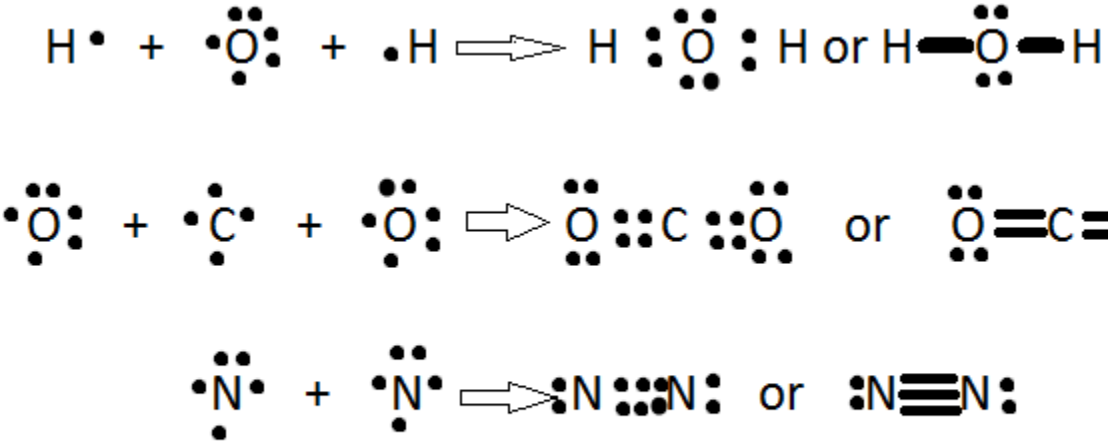




1.1.2 Covalent Bonding

A covalent bond indicates the sharing of electrons between atoms. Compounds that contain carbon (also called organic compounds) .





All these diagrams show the formation of covalent bonds as electrons from elements are shared to form single, double, and triple bonds

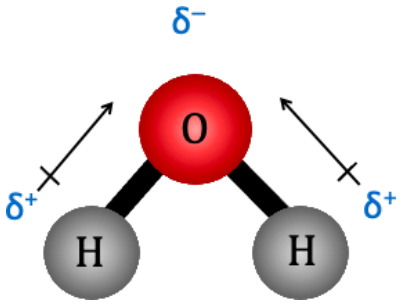
Differences between Ionic and Covalent Compounds

Ionic Compounds	Covalent Compounds
Have very high melting and boiling points	Have low melting and boiling points
Conduct electricity when molten or in aqueous solution	Cannot conduct electricity in any state
Are usually soluble in water, but insoluble in organic solvents	Are usually insoluble in water, but soluble in organic solvents

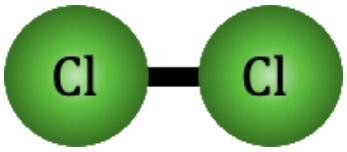
Polar and Non-polar molecules

Polar and Non-Polar Bonds

1. **Polar Bond**:
   A polar bond occurs when two atoms share electrons unequally. This happens because one atom is more electronegative (attracts electrons more strongly) than the other, creating a slight positive charge on one side and a slight negative charge on the other.
   Example: Water (H_2O), where oxygen attracts electrons more strongly than hydrogen.

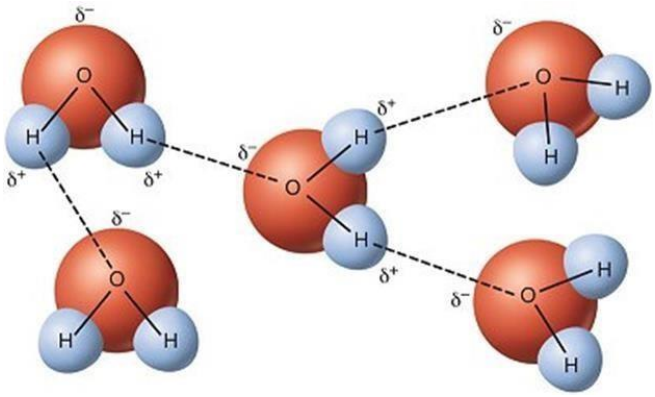


2. **Non-Polar Bond**:
   A non-polar bond happens when two atoms share electrons equally because they have the same or very similar electronegativity. There is no charge difference across the bond.
   Example: Oxygen gas (O_2), where both oxygen atoms share electrons equally.



1.1.3 Hydrogen Bonding

- Compared to ionic and covalent bonding, Hydrogen bonding is a weaker form of chemical bonding.
- It is a type of polar covalent bonding between oxygen and hydrogen, wherein the hydrogen develops a partial positive charge.
- This implies that the electrons are pulled closer to the more electronegative oxygen atom.
- This type of chemical bonding called a hydrogen bond and is responsible for many of the properties exhibited by water.



1.1.4 Metallic bonding

Definition: Is the electrostatic force of attraction between the positive metal ions and the delocalized electrons.

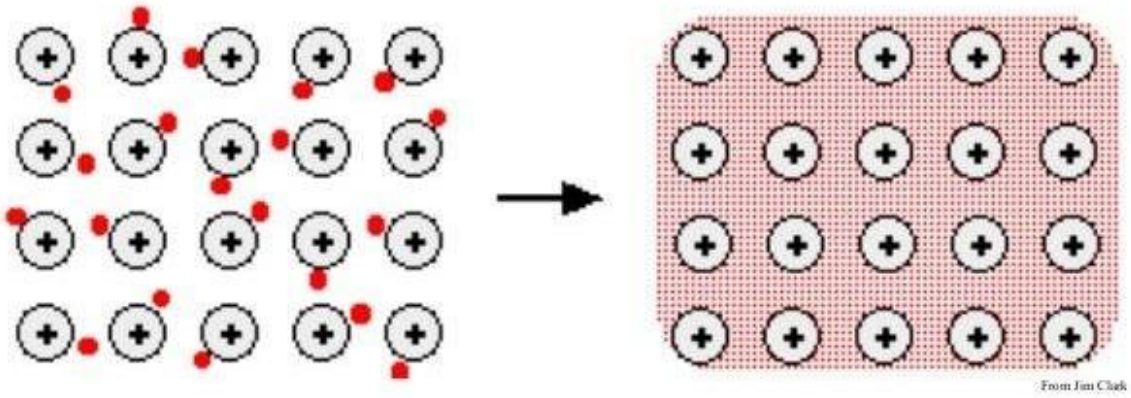
The three main factors that affect the strength of metallic bonding are:

1. Number of protons Strength of nuclear attraction. The more protons the stronger the bond

2. Number of delocalized electrons per atom the more delocalized electrons the stronger the bond

3. Size of ion the smaller the ion, the stronger the bond.

Metallic Bonds



From Jim Clark

A metallic bond is produced when electron orbitals overlap and all electrons are shared between atoms. This is often referred to as a "sea of electrons," and is responsible for the high conductivity, reflectivity, malleability, and ductility of metals. Metallic bonding is restricted to atoms of a single element.