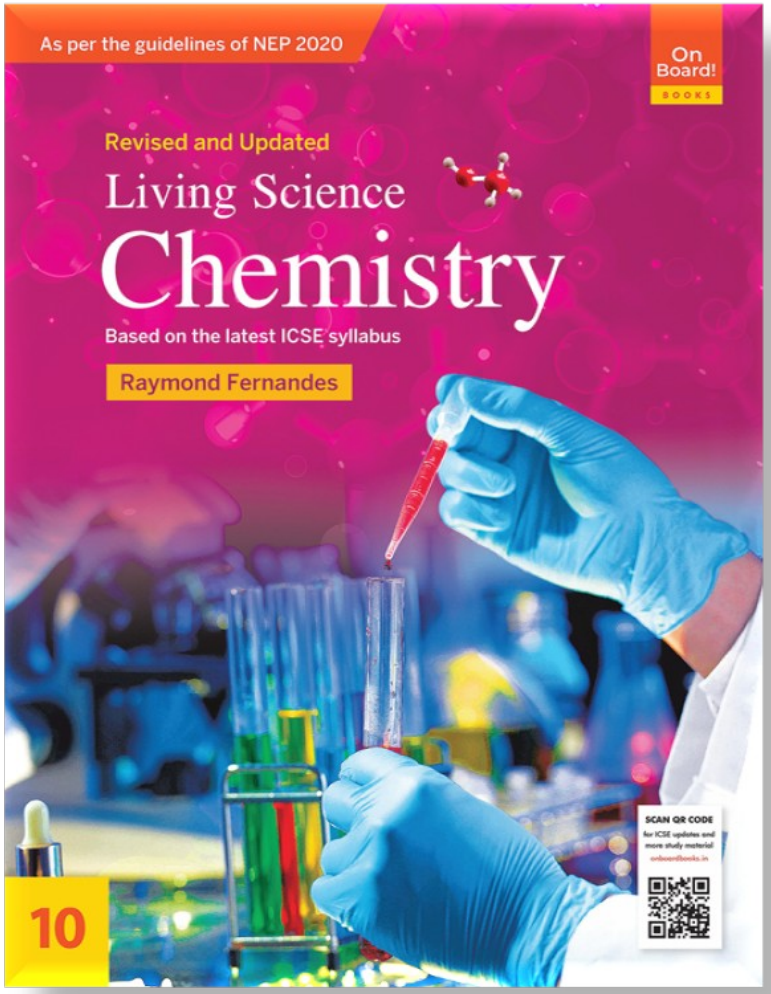
On Board!

ICSE
Living Science
Chemistry

Class 10

Chapter-2 Chemical Bonding


As per the guidelines of NEP 2020
On Board! BOOKS
Revised and Updated
Living Science
Chemistry
Based on the latest ICSE syllabus
Raymond Fernandes
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LEARNING OBJECTIVES

Why do Elements Undergo Bond Formation?

- **Electronic Dot Structure**

Ionic or Electrovalent Bond

Structure of Some Ionic Compounds

- **Characteristic properties of ionic compounds**

Covalent Bond

- **Types of covalent bonds**
- **Characteristic properties of covalent compounds**
- **Conditions favouring the condition of a covalent bond**
- **Polar covalent compounds**
- **Non-polar covalent compounds**

Coordinate Bond

Chemical bond and its types?

A chemical bond is a strong attractive force that exists between the atoms which holds them together as a stable unit.

Chemical bonds are of three types:

a. Ionic or electrovalent bond

b. Covalent bond

c. Coordinate or dative bond

Why Do Elements Undergo Bond Formation?

Elements are made of atoms which comprise electrons , protons and neutrons. The protons and the neutrons are located within the nucleus and this gives the nucleus positive charge. The electrons revolve around the nucleus in definite regions called **orbits**. Each orbit has some maximum capacity of electrons that it can accommodate. The electrons in the last shell, called the **valence shell**, are responsible for all the chemical reactions of that element. Every atom of an element tries to attain a stable outer octet (8 electrons in last shell) or duplet (2 electrons), i.e. nearest to He configuration) and to achieve this stable electronic configuration, it either gains, loses or shares its valence electrons, and in this process bond formation takes place.

Electron dot structure

In this representation, the symbol of the element represents the nucleus and the electrons in the inner shells. The dots on the symbol represent the number of valence electrons. For example, the atomic number of chlorine is 17.

Electronic configuration 2, 8, 7

Valence electrons 7

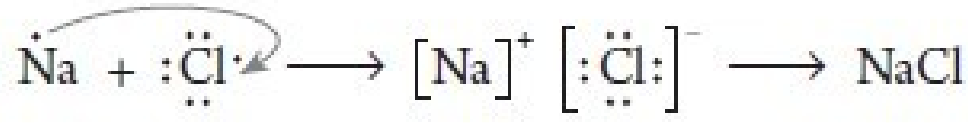
Electron dot structure 

Ionic or Electrovalent Bond

The compounds formed as a result of transfer of electrons from a metal to a non-metal atom are called **ionic or electrovalent compounds**. The number of electrons that an atom donates or accepts to form an electrovalent bond is called its **electrovalency**.

Ionic or electrovalent bond is formed between metal and non-metal atoms. Metals tend to transfer their valence electrons to non-metals, and non-metals tend to accept electrons from metals to achieve their octets.

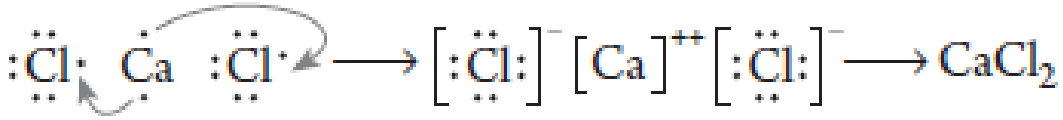
Ionic bond formation in sodium chloride



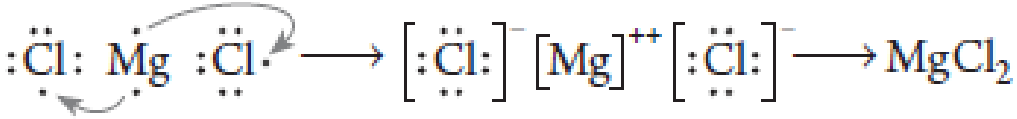
During the formation of this electrovalent bond between sodium and chlorine, the transfer of a single electron from the electron cloud of sodium to the electron cloud of chlorine constitutes a chemical change. Since sodium loses an electron, it gets oxidized to the sodium ion and chlorine gains electron to get reduced to the chloride ion. This suggests that whenever a metal loses electrons, it undergoes oxidation and if non-metal gains electrons, it undergoes reduction.

Structures of Some Ionic Compounds

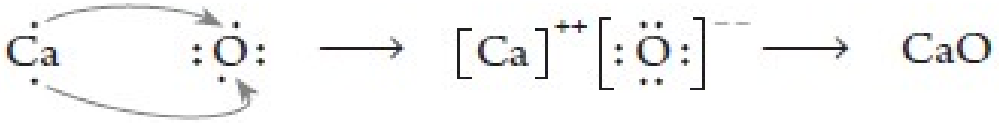
1. Calcium chloride



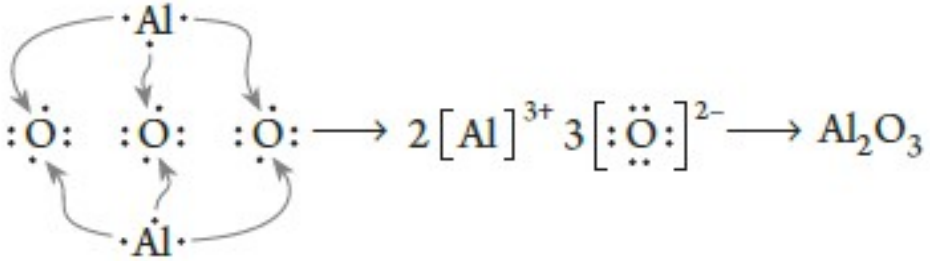
2. Magnesium chloride



3. Calcium oxide



4. Aluminium oxide



Study Tip

Elements having 1, 2 or 3 valence electrons always form ionic bonds with elements having 5, 6 or 7 valence electrons.

Characteristic properties of ionic compounds

1. Physical state: Ionic compounds exist as hard crystalline solids at room temperature as their constituent ions are closely packed with strong electrostatic forces of attraction.

2. Melting and boiling points: They have high melting and boiling points due to the presence of strong electrostatic forces of attraction and to break these forces of attraction, a large amount of energy is required.

3. Conduction of heat and electricity: These compounds are good conductors of heat and conduct electricity only in molten (fused) or aqueous state. They do not conduct electricity in solid state as constituent ions are not free to move and bonded by strong electrostatic forces of attraction. In aqueous or molten state, constituent ions are free to move.

4. Solubility: They are generally soluble in water but do not dissolve in organic solvents.

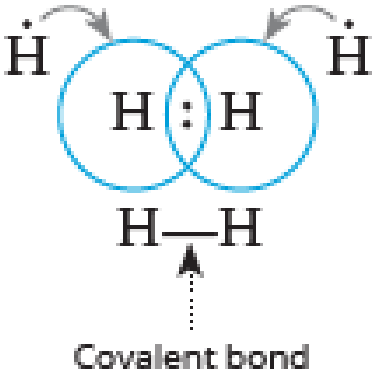
5. Dissociation: In molten or aqueous state, on passage of electric current, they undergo electrolytic dissociation to give their constituent ions. On electrolysis, the ions being charged are attracted towards their respective electrodes.

6. Volatility: These compounds are non-volatile in nature.

7. Rate of reaction: The rate of reaction of these compounds is very high as they can readily form ions in solution.

Covalent Bond

The chemical bond formed due to mutual sharing of electrons by combining atoms is called a **covalent bond**. Covalent bonds are formed between two non-metals. In this type of bonding electrons are not transferred but shared. Each atom contributes equal number of electrons. Covalent bonding results in the formation of molecules. Compounds formed by sharing of electrons are called **covalent compounds**.



Types of covalent bonds

The covalent bonds are of the following types:

1.Single covalent bond

2.Double covalent bond

3.Triple covalent bond

A covalent bond formed by sharing of one pair of electrons is called **single covalent bond**. The covalent bond formed by sharing of two pairs of electrons between the two atoms is called **double covalent bond**. The **triple covalent bond** is formed by sharing of three pairs of electrons.

The number of electron pairs shared by an atom with one or more atoms is called **covalency**.

Characteristic properties of covalent compounds

1. Physical state: Covalent compounds generally exist as gas, liquids or soft solids. This is due to the presence of weak forces of attraction between them.

2. Melting and boiling points: The molecules of a covalent compound are held together by relatively weaker forces as compared to that in ionic compounds. Therefore, melting and boiling points of covalent compounds are generally low.

3. Conduction of heat: These compounds are bad conductors of heat.

4. Conduction of electricity: These compounds do not conduct electricity in their molten or aqueous state because they contain neither the ions nor free electrons required for conduction.

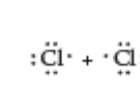
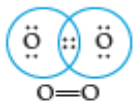
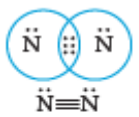
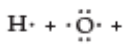
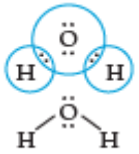
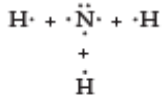
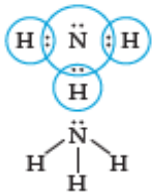
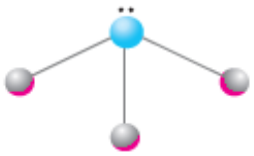
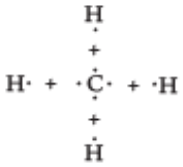
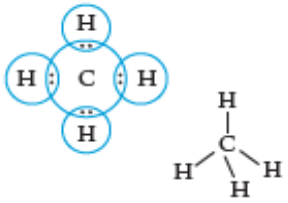
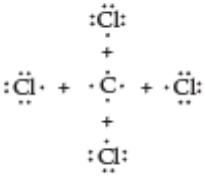
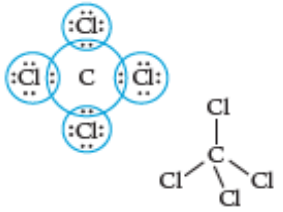
5. Ionization in solution: Non-polar covalent compounds do not ionize in water but polar covalent compounds ionize in solution, like HCl.

6. Solubility: They are generally insoluble in polar solvents like water but dissolve in non-polar solvents or less polar solvents like ether, benzene, etc.

7. Volatility: They are volatile in nature.

8. Rate of reaction: The rate of reaction of these compounds is low as energy is required to break and make bonds.

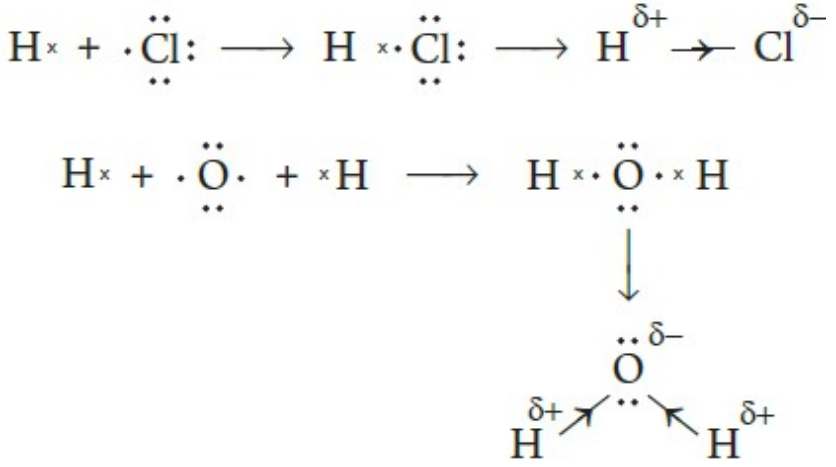
Study Tip: Covalent bonds are always formed among non-metallic elements.

Name	Electron dot structure		Structure
	Before combination	After combination	
1. Chlorine			
2. Oxygen			
3. Nitrogen			
4. Water			
5. Ammonia			
6. Methane			
7. Carbon tetrachloride			

Structure of some covalent compounds.

Polar covalent compounds

The covalent compounds possessing a polar covalent bond are called **polar covalent compounds**. In such compounds, shared pair of electrons is not at equal distance between the two atoms and lies closely to the more electronegative atom. This results in charge separation in these compounds. Hence, such compounds ionize in water.



Non-polar covalent compounds

The covalent compounds possessing non-polar covalent bonds are called **non-polar covalent compounds**. In such compounds, the shared pair of electrons is equally distributed between the two atoms as well as equally attracted by the two atoms. Such compounds are electrically neutral and involve no charge separation between the two atoms. Hence, they do not ionize in water. For example, H_2, Cl_2, O_2, N_2, F_2, Br, etc.

Note: Refer to Table 2.4 of the textbook for Differences between electrovalent and covalent compounds

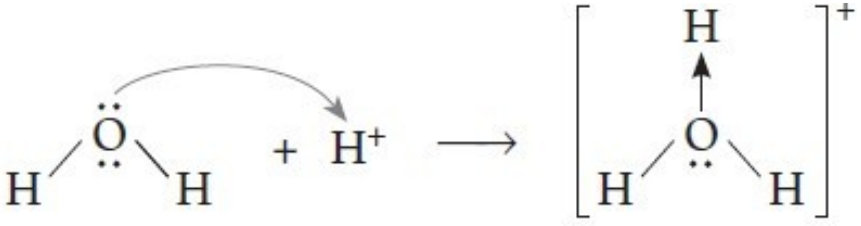
Coordinate Bond

A chemical bond formed by sharing a pair of electrons between two atoms, both of which are provided by only one of the combining atoms is called **coordinate bond**. The atom which provides the electron pair for the formation of coordinate bond is called **donor** and the atom or ion sharing donated electron pair is called **acceptor**. For example bond formation in Hydronium ion and Ammonium ion.

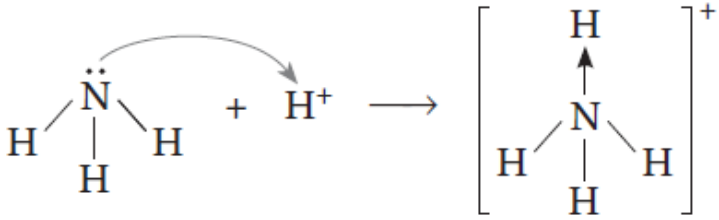
A coordinate bond is denoted by an arrow (→) pointing from a donor atom towards the acceptor atom.

Note: It is the lone pair of electrons of donor atom that participates in coordinate bond.

Coordinate bond formation in hydronium ion



Coordinate bond formation in ammonium ion



Note: Ammonium chloride is the only compound containing all the three types of bonds, i.e. covalent, coordinate and ionic bonds. The ionic bond is present between ammonium ion (a cation) and chloride ion (an anion).

SUMMARY

1. Chemical bond: A strong attractive force that holds atoms or ions or molecules together.

2. Cause of chemical bonding: To attain stable electronic configuration (nearest to a noble gas). Noble gases are chemically less reactive and have eight electrons (except helium) in their valence shell.

3. Chemical bonds are of three types: Ionic or electrovalent bonds, covalent bonds and coordinate or dative bonds.

4. Ionic or electrovalent bond: It is a strong electrostatic force of attraction between oppositely charged ions that holds them together. This type of bond is formed by the transfer of electrons from metal to non-metal atoms. The compounds containing ionic or electrovalent bond are called ionic or electrovalent compounds. For example, sodium chloride, calcium oxide, magnesium oxide.

5. Electrovalency: It is the number of electrons that an atom donates or accepts to form an electrovalent bond.

6. Covalent bond: It is the bond formed due to the mutual sharing of electrons by combining atoms. In covalent bond, each atom contributes equal number of electrons. The compounds containing covalent bonds are called covalent compounds. They are generally formed between two non-metals and result in the formation of molecules.

7. Covalency: It is the number of electron pairs shared by an atom with one or more atoms during the formation of a covalent bond.

8. Type of covalent bonds: There are three types of covalent bonds: single, double and triple bonds that are formed by the mutual sharing of one, two and three electron pairs between two atoms respectively.

9. Bond pair of electrons: It is the pair of electrons shared between two atoms.

10. Lone pair of electrons: It is the pair of electrons that does not take part in bond formation.

11. Coordinate bond: The bond formed between two atoms in which both the electrons are provided by one of the two atoms and is shared by both of them. For example, ammonium ion and hydronium ion.

THANK YOU