CHEMICAL BONDING

- **CHEMICAL BOND:** A chemical bond may be defined as the force of attraction between any two atoms, in a molecule, to maintain stability.
- Cause of chemical combination is the tendency of elements to acquire the nearest noble gas configuration in their outermost orbit and become stable.
- Three methods in which atoms can achieve a stable configuration:

Electrovalent / Ionic bond	Covalent / Molecular bond	Coordinate bond
• The transfer of one or more electrons from one atom to the other to form an ionic or electrovalent bond	• Sharing of one, two or three pairs of electrons between two atoms to form a covalent/molecular bond.	• When the shared electron pairs are contributed by only one of the combining atoms, the bond formed is called coordinate bond.

ELECTROVALENT BOND / IONIC BOND:

A chemical bond that is formed due to the electrostatic force of attraction between a cation and an anion is called Electrovalent or an Ionic bond.

- **Electrovalent Compounds:** The chemical compounds formed as a result of the transfer of electrons from one atom of an element to one atom of another element are called ionic or electrovalent compounds.
- **Electrovalency:** The number of electrons that an atom of an element loses or gains to form an electrovalent bond is called electrovalency.

CONDITIONS FOR THE FORMATION OF AN ELECTROVALENT OR IONIC BOND:

⇒ LOW I.E

- If the ionisation potential of a particular atom is low, it will lose electron(s) easily i.e. a cation is formed easily.

⇒ HIGH E.A

- If the electron affinity value is high, anion will be formed easily.
- A higher electron affinity value favours ionic bonding

⇒ LARGE ELECTRONEGATIVITY DIFFERENCE

- Higher the electro-negativity difference, more will be the ionic nature of the resulting compound.

PROPERTIES OF ELECTROVALENT COMPOUNDS:

1. NATURE: Their constituent particles are ions. They are hard solids consisting of ions.

Reason: They have strong electrostatic forces of attraction between their ions, which cannot be separated easily

2. BOILING POINT AND MELTING POINT: These are non-volatile, having high mpt and b.pt

Reason: • There exists a strong force of attraction between the oppositely charged ions, so a large amount of energy is required to break the strong bonding force between ions.

3. CONDUCTING NATURE: They do not conduct electricity in the solid state. They are good conductors of electricity in the fused or in aqueous state.

Reason: Electrostatic forces of attraction between ions in the solid state are very strong. These forces weaken in fused state or in solution state. Hence, ions become mobile.

4. DISSOCIATION: Electrovalent compounds are composed of ions. In solution, these ions become mobile or in molten state these ions dissociate. Their ions dissociate and migrate when an electric current passes through them in their molten or aqueous solution state.

$$NaCl_{(m)} \rightleftharpoons Na^+ + Cl^-$$

Reason: Water being a polar covalent compound decreases the electrostatic forces of attraction resulting in free ions in aqueous solution. Ions dissociate in water or in molten state.

- Electrovalent compounds are good conductors of heat.

5. Solubility : These are soluble in water but insoluble in organic solvents.

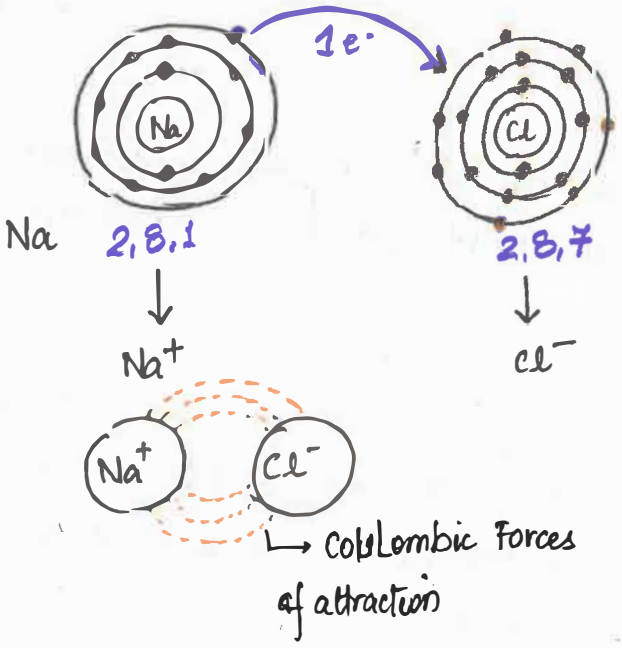
Reason : Water being a polar covalent compound, it decreases the electrostatic forces of attraction, resulting in free ions in aqueous solution.

6. RATE OF REACTION : They show rapid speed of chemical reactions in aqueous solutions.

Reason : Free ions are easily formed in different solutions, they unite very fast forming compounds.

STRUCTURES OF SOME ELECTROVALENT COMPOUNDS :

1) SODIUM CHLORIDE (NaCl)

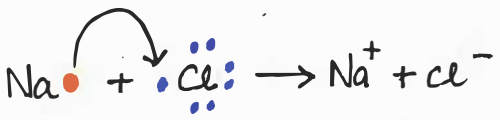


• PROPERTIES OF SODIUM ATOM AND SODIUM ION :

SODIUM ATOM (Na)	(Na^+) SODIUM ION
1. Silvery white	Colourless
2. Poisonous	Non-Poisonous
3. Very active	Inactive
4. Incomplete outermost shell	complete outermost shell
5. Neutral	Positively charged
6. Combined state	Independent Existence

CHLORINE ATOM (Cl)	CHLORIDE ANION (Cl^-)
1) Yellowish green	Colourless
2) Poisonous	Non poisonous
3) Suffocating	odourless
4) Very active	Inactive
5) Incomplete outermost shell	Complete outermost shell
6) Neutral	Negatively charged
7) Not independent	Independent

ELECTRON DOT STRUCTURE OF SODIUM CHLORIDE :



OR

NaCl
sodium chloride

COVALENT BOND / MOLECULAR BOND

The chemical bond that is formed between two combining atoms by mutual sharing of one or more pairs of electrons is called covalent bond and the compound formed due to this bond is called covalent compound

TYPES OF COVALENT BOND :

- Single covalent bond : Formed by sharing of one pair of electrons b/w the atom
  $H-H$, $Cl-Cl$, $H-O-H$, $H-Cl$
- Double covalent bond : Formed by the sharing of two pairs of electrons b/w two atoms. $O=O$, $O=C=O$
- Triple covalent bond : Formed by the sharing of three pairs of electrons b/w two atoms. $N\equiv N$, $H-C\equiv C-H$

COVALENT COMPOUNDS

NON-POLAR COVALENT COMPOUNDS :

Covalent compounds are non polar when shared pair of electron(s) are equally distributed between the two atoms.

Eg: O_2, Cl_2, H_2.

POLAR COVALENT COMPOUNDS :

Covalent compounds are said to be polar when the shared pair of electrons are not at equal distance b/w the two atoms.

- This develops the fractional +ve and -ve charges on them.

Eg: $H-Cl$ ($H^{\delta+}-Cl^{\delta-}$), H_3N ($N^{\delta-}$, $H^{\delta+}$), H_2O ($O^{\delta-}$, $H^{\delta+}$)

- Since a polar covalent molecule has both positive and negative poles, it is also known as 'DIPOLE MOLECULE'

CONDITIONS FOR FORMATION OF A COVALENT BOND:

1) Both atoms should have 4 or more electrons in their outermost shells
2) Both atoms should have high electronegativity
3) Both atoms should have high electron affinity
4) Both atoms should have high ionisation energies
5) The electronegativity difference between the combining atoms should be either zero or negligible.

PROPERTIES OF COVALENT COMPOUNDS:

1) NATURE: Their constituent particles are molecules. These are gases or liquids or soft solids

Reason: They have weak forces of attraction.

2) BOILING POINT AND MELTING POINT: These are volatile, with low mpt and b.pt

Reason: They have weak forces of attraction

3) CONDUCTING NATURE: They are non-conductors of electricity in solid, molten or aqueous state

Reason: Due to absence of free ions

4) IONISATION IN SOLUTIONS:

- NON POLAR COVALENT COMPOUNDS $\xrightarrow[\text{CURRENT}]{\text{ELECTRIC}}$ NO IONS

POLAR COVALENT COMPOUNDS $\xrightarrow{\text{ELECTRIC CURRENT}}$ IONISE IN THEIR SOLUTION

$$HCl + H_2O \rightleftharpoons H_3O^+ + Cl^-$$

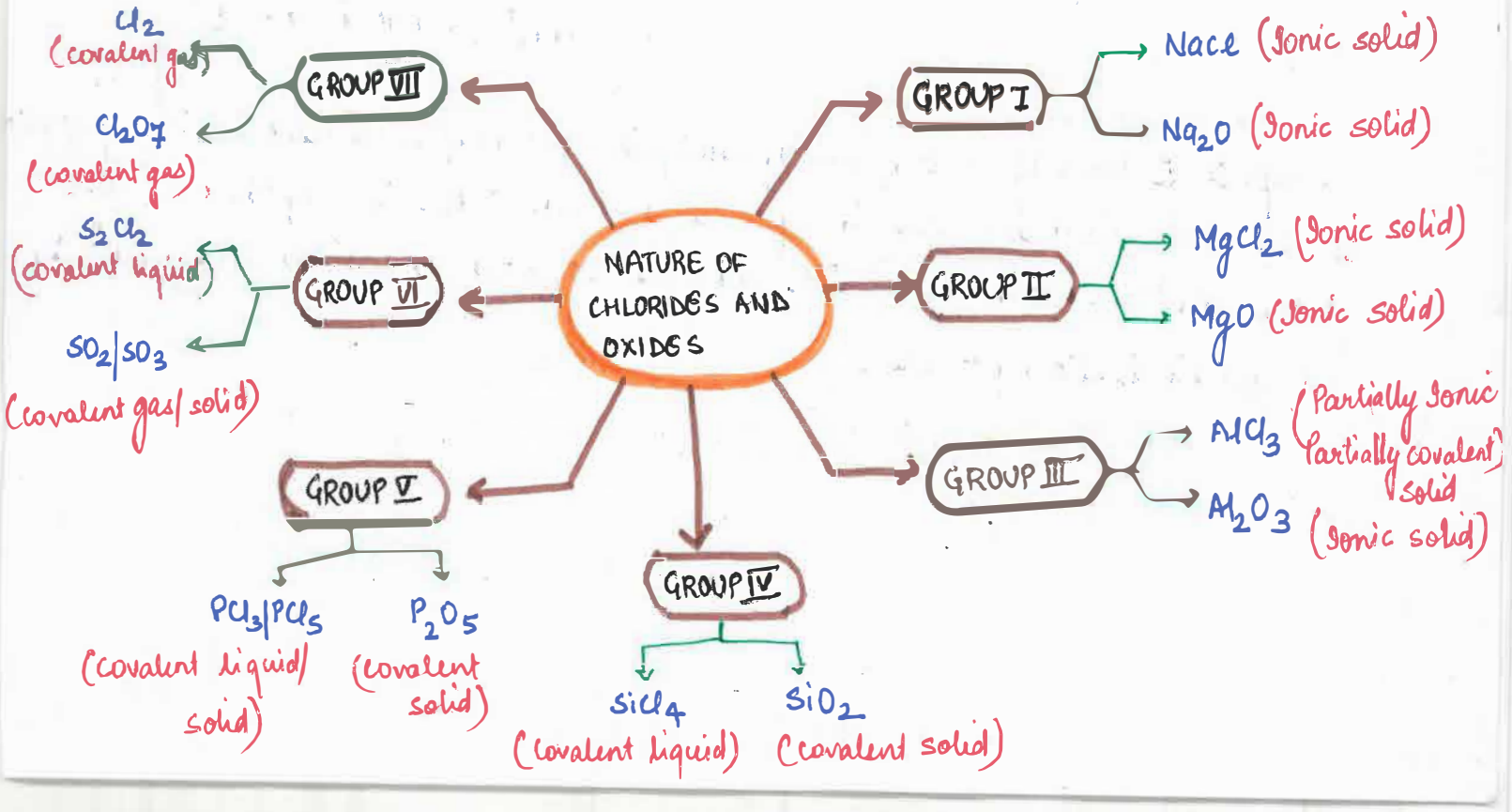
- Covalent compounds are poor conductors of heat.

5) SOLUBILITY: They are insoluble in water but dissolve in organic solvents

Reason: As organic solvents are non-polar, hence these dissolve in non-polar covalent compounds

6) RATE OF REACTION: In aqueous solutions, their rate of reaction is slow.

Reason: In covalent molecules, reactions are accompanied by breaking of old bonds and creation of new bonds, thus the reaction is slow.



COORDINATE BOND:

The bond formed between two atoms by sharing a pair of electrons, provided entirely by one of the combining atoms but shared by both is called COORDINATE BOND / DATIVE BOND.

Eg: H_3O^+ (Hydronium ion), NH_4^+ (Ammonium ion)

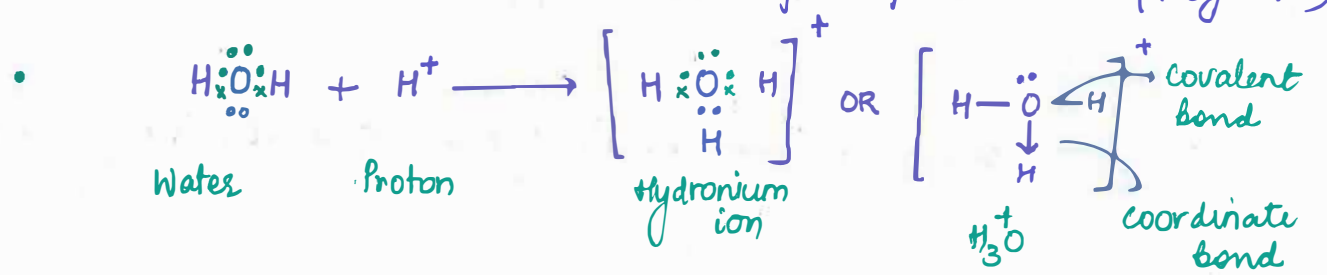
CONDITIONS FOR THE FORMATION OF COORDINATE BOND:

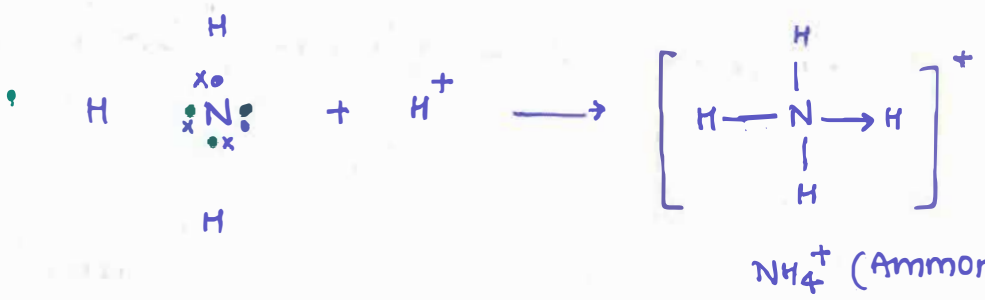
1) One of the two atoms must have atleast one lone pair of electrons.

Eg: NH_3, H_2O

The lone pair of electrons is provided to the other atom for the formation of coordinate bond.

2) Another atom should be short of atleast a pair of electrons. Hydrogen (H^+)





SELF IONISATION OF WATER:

Self-ionisation of water / autoprotolysis of water / autodissociation of water is an ionisation of water in aqueous medium. Water is amphiprotic, one water molecule can react with another to form an OH^- ion and an H_3O^+ in an autoionisation process.

$$2H_2O(l) \rightleftharpoons H_3O^+(aq) + OH^-(aq)$$