

Chemical Bonding

Chemical Bond

A chemical bond is defined as the force of attraction between any two atoms in a molecule to maintain stability.

Noble Gases

- Have stable electronic configuration, i.e. their outermost shell is complete.
- They have 2 electrons in the outermost shell or 8 electrons in the outermost shell.
- They do not lose, gain or share electrons and are inert or unreactive.

Atoms of Elements – Other than Noble Gases

- Have unstable electronic configuration, i.e. their outermost shell is incomplete.
- They can lose, gain or share electrons and are chemically reactive.

Reasons for Chemical Bonding

- The driving force for atoms to combine is related to the tendency of each atom to attain stable electronic configuration of the nearest inert noble gas.
- For an atom to achieve stable electronic configuration, it must have
Two electrons in the outermost shell (nearest noble gas He) – **Duplet rule**
Eight electrons in the outermost shell (all noble gases other than He) – **Octet rule**

Methods for achieving Chemical Bonding

There are three methods in which atoms can achieve a stable configuration:

- Electrovalent bond
- Covalent bond
- Coordinate bond

Electrovalent (or Ionic) Bond

- **Ionic bond**

The chemical bond formed between two atoms by transfer of one or more electrons from the atom of a metallic electropositive element to an atom of a non-metallic electronegative element.

- **Ionic compound**

The chemical compound formed as a result of transfer of one or more electrons from the atom of a metallic electropositive element to an atom of a non-metallic electronegative element.

- **Electrovalency**

The number of electrons donated or accepted by the valence shell of an atom of an element so as to achieve stable electronic configuration is called electrovalency.

Conditions for the formation of an Ionic Bond

Ionisation potential (IP): Lower the value of IP of a metallic atom, greater the ease of formation of the cation.

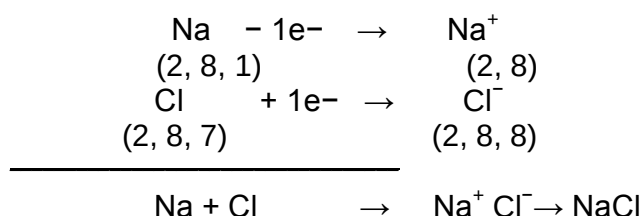
Electron affinity: Higher the value of EA of a non-metallic atom, greater the ease of formation of the anion.

Electronegativity: Larger the differences in electronegativity between the combining atoms, greater the ease of electron transfer.

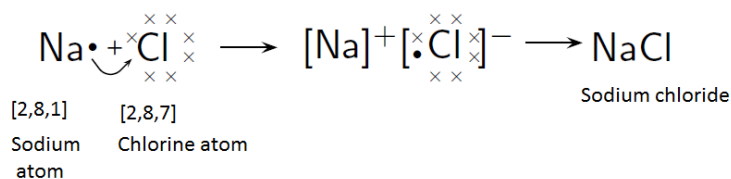
Formation of electrovalent compounds

Formation of Sodium Chloride

1] Ionic equation



2] Electron dot structural diagram



Covalent Bond

- **Covalent bond:** The chemical bond formed due to mutual sharing of electrons between the given pairs of atoms of non-metallic elements.
- **Covalent compound:** The chemical compound formed due to mutual sharing of electrons between the given pairs of atoms, thereby forming a covalent bond between them.
- **Covalency:** The number of electron pairs which an atom shares with one or more atoms of the same kind or different kind to achieve stable electronic configuration is called covalency.
- **Non-polar covalent compounds:** Covalent compounds are said to be non-polar when the shared pair of electrons are equally distributed between the two atoms.
Examples: H_2 , Cl_2 , O_2 , N_2 , CH_4 , CCl_4
- **Polar covalent compounds:** Covalent compounds are said to be polar when a shared pair of electrons are unequally distributed between the two atoms.
Examples: H_2O , NH_3 , HCl

Conditions for formation of covalent compound

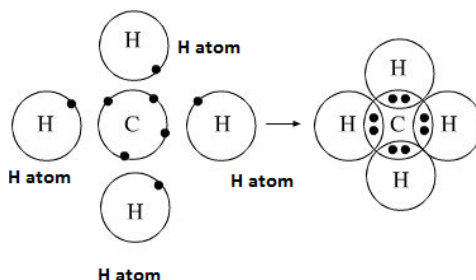
Ionisation potential, electron affinity and electronegativity: High between both the atoms.

Electronegativity difference: Should be negligible between the two combining atoms.

Formation of methane molecule – Non-polar covalent compound

Atom	Electronic configuration	Nearest noble gas	To attain stable electronic configuration of nearest noble gas
Carbon	$^{12}_{6}\text{C}$ [2,4]	Neon [2,8]	Carbon needs four electrons to complete the octet.
Hydrogen	^1_1H [1]	Helium [2]	Hydrogen needs one electron to complete the duplet.

One atom of carbon shares four electron pairs, one with each of the four atoms of hydrogen.



Coordinate Bond

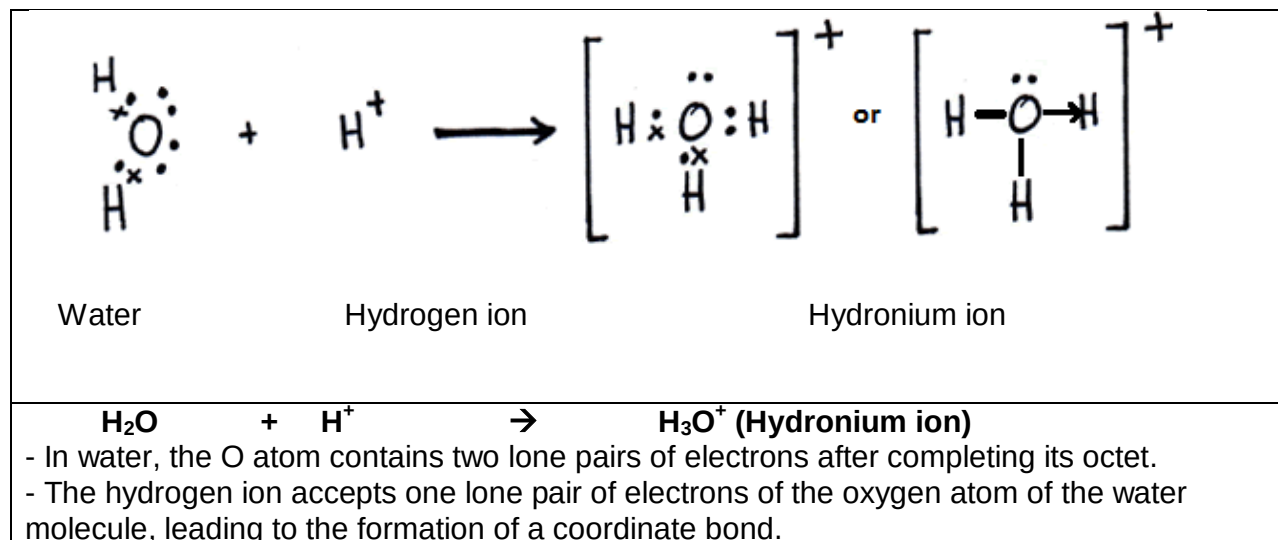
The bond formed between two atoms by sharing a pair of electrons provided entirely by one of the combining atoms but shared by both is called a coordinate bond or dative bond.

Examples: Ammonium ion (NH_4^+), hydronium ion (H_3O^+)

A coordinate bond has properties of both covalent and ionic bonds. So, it is also called a co-ionic bond.

- **Lone pair of electrons:** A pair of electrons which is not shared with any other atom is known as a lone pair of electrons. It is provided to the other atom for the formation of a coordinate bond.
- **Conditions for the formation of coordinate bond**
 1. One of the two atoms must have at least one lone pair of electrons. Examples: Ammonia (NH_3), water (H_2O)
 2. Another atom should be short of at least one lone pair of electrons. Example: Hydrogen ion (H^+)

- **Formation of hydronium ion $[H_3O^+]$**



- **Properties and comparison of electrovalent and covalent compounds**

Electrovalent compounds	Covalent compounds
These are hard solids consisting of ions.	These are gases, liquids or soft solids.
These are non-volatile, with high boiling and high melting points.	These are volatile, with low boiling and low melting points.
They are good conductors of electricity in the fused state.	They are non-conductors of electricity in solid, molten or aqueous state.
The dissociation of molecules into ions occurs when the current passes through them.	The dissociation of molecules into ions does not occur.
These are soluble in water but insoluble in organic solvents.	These are insoluble in water but dissolve in organic solvents.
They show rapid speed of chemical reactions in aqueous solutions.	They show slow speed of chemical reactions in aqueous solutions.

Redox Reaction

- **Oxidation:** When an atom or ion loses an electron or electrons, oxidation takes place.
- **Reduction:** When an atom or ion gains an electron or electrons, reduction takes place.
- **Oxidising agents:** The atom or ion which gains an electron or electrons is an oxidising agent.
- **Reducing agents:** The atom or ion which loses an electron or electrons is a reducing agent.
- **Redox reaction:** A chemical reaction in which the loss and gain of electrons take place simultaneously is called a redox reaction.

Example:

