 ISBN: 978-93-343-9868-7

Chapter 11

# Chemical Bonding

**Chetan Kumar Bose,** Department of Chemistry

**Shri Jain Terapanthi College, Ranawas, Pali**

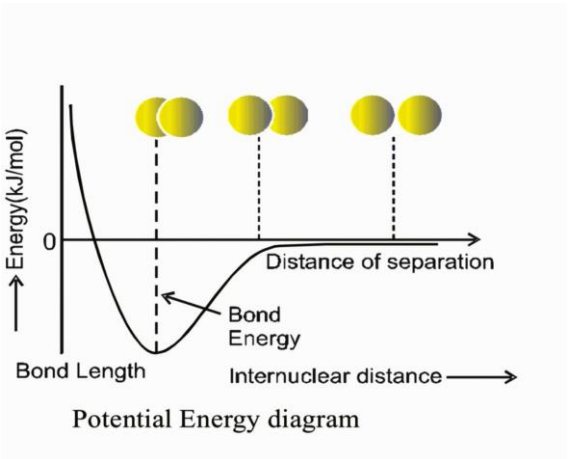
**Interduction-**

It is a well-known fact that apart from inert gases, no other element can exist in the form of free atoms under normal conditions. Most elements exist in the form of molecules, which are groups of atoms that combine to form molecules. There is a reduction in energy in the formation of molecules from single atoms, due to which molecules are more stable than atoms. A common atom contains a nucleus composed of protons and neutrons, with electrons in certain energy levels revolving around the nucleus. In this section, the main focus will be on these electrons. Elements are distinguishable from each other due to their "**electron cloud,**" or the area where electrons move around the nucleus of an atom. Because each element has a distinct electron cloud, this determines their chemical properties as well as the extent of their reactivity **(i.e. noble gases are inert/not reactive while alkaline metals are highly reactive).** In chemical bonding, only valence electrons, electrons located in the orbitals of the outermost energy level **(valence shell)** of an element, are involved.

***Chemical Bond –***

Chemical bonding is the process by which two or more atoms join together to form a molecule or compound. This bond arises due to the exchange or sharing of electrons between atoms, creating an electrostatic force of attraction that holds them together.

- A chemical bond is a force that holds atoms together, causing them to form a stable structure. This bond is due to the attraction between electrons, which are either transferred from one atom to the other or shared by both the atoms.
- A force when acts between two or more atoms to hold them together as a stable molecule, the bond thus formed is chemical bond.
- It is group of two or more atoms involving redistribution of electrons among them.
- This process accompanied by decrease in energy.
- **Decrease in energy ∝ Strength of the bond.**



Potential Energy diagram

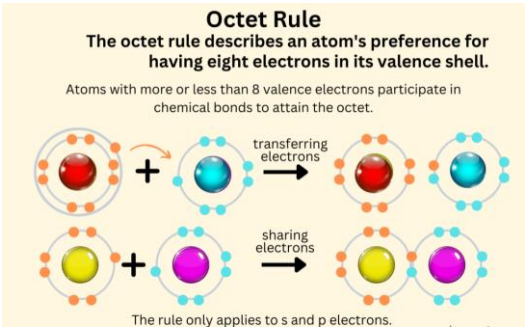
- Therefore molecules are more stable than atoms.

Example - **$O_2$, $Ca(OH)_2$, $N_2$, NaCl** etc.

**Due to Chemical Combination**

 ISBN: 978-93-343-9868-7

1. **The tendency to retain minimum Energy -**
   - When two atoms comes closer, nucleus of one atom attracts the electron of another atom.
   - The Nucleus and the electrons of the two atoms repel each other.
   - When net result is attraction, the total energy of the system (molecule) decreases and chemical bond forms.
   - Bond formation is an exothermic process.
   - **Attraction ∝ 1/energy ∝ Stability**
2. **Tendency of acquire noble gas configuration -**
   - Atom combines to acquire noble gas configuration.
   - In formation of bond only outermost electron i**.e. ns, np and (n-1)d** electrons participate
3. **Octet Rule -**
   - The octet rule was given by German chemist **Walther Kossel** and American chemist **Gilbert Newton Lewis**.
   - Atoms combine together to complete their outer shells with **8 electrons.** The outer shells filled with eight electrons are most stable. All the outer shells have a tendency to complete their outer shells with eight electrons and attain stable configuration **(S2 P6).**




   - The octet rule is a chemistry rule of thumb that says that atoms combine in a way that gives them eight electrons in their valence shells. This achieves a stable electron configuration similar to that of noble gases.
   - The steps to complete the octave are as follows :

**(i)** Complete transfer of electrons from one atom to another occurs due to.
Example - **NaCl, $CaCl_2$, MgO** etc. {**Ionic Bond**}

**(ii)** By Sharing of same electrons between two atoms.
Example - **$Cl_2$, $O_2$, $N_2$** etc {**Covalent Bond**}

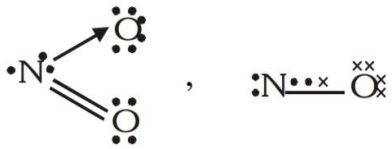
**(iii)** By Sharing of electron pairs of only one atom.
Example - [**$NH_3 \rightarrow H^+$**] &
**$NH_3 \rightarrow BF_3$** {**Co-ordination Bond** }.

**Exceptions to the Octave Rule-**

1. **Transition metal ion - $Cr^{3+}$, $Mn^{2+}$, $Fe^{2+}$**
   **[Ar]3d3., [Ar]3d5. [Ar]3d6**
   **[2, 8, 11], [2, 8, 13], [2, 8, 14]**
2. **Pseudo inert gas configuration [s2 p6 d10 ] -**
   **$Zn^{2+}$, $Cd^{2+}$**
   **$[Ar]3d^{10}$, $[Kr]4d^{10}$**
3. **Contraction of octave (incomplete octal) -**
   **BeF, $BF_3$, $AlCl_3$, $BCl_3$**
   **(4e) (6e) (6e) (6e)**
4. **Expansion of octet (due to vacant d orbitals) -**
   **$PCl_5$ $SF_6$ $ClF_3$ $ICl_5$ $IF_7$**
   **⬇□ ⬇□ ⬇□ ⬇□ ⬇□**
   **(10e) (12e) (10e) (12e) (14e)**
5. **Odd electron species -** A molecule or ion that has an odd number of electrons resulting in at least one unpaired

 ISBN: 978-93-343-9868-7

electron. **Example: NO, NO2, $ClO_2$ etc.**



6. **Compounds of noble gases -** Generally the noble gases whose octet is already complete (**except He)** do not form compounds.Some of its compounds have been prepared, such as **$XeF_2$, $XeF_6$** and **$KrF_2$** etc.