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**CHEMISTRY**

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CLASS 11 & 12th



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CLASS 11th

# Chemical Bonding & Molecular Structure

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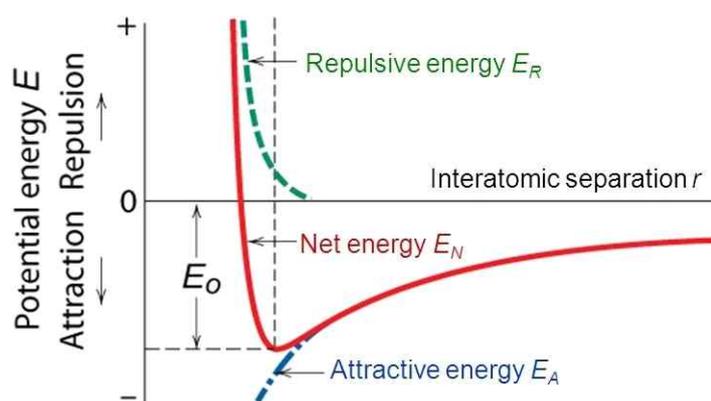


## 01. Chemical Bond

- A force that acts between two or more atoms to hold them together as a stable molecule.
- It is union of two or more atoms involving redistribution of electron among them.
- This process accompanied by decrease in energy.
- Decrease in energy  $\propto$  Strength of the bond.
- Therefore molecules are more stable than atoms.

## 02. Cause of Chemical Combination

**Tendency to acquire minimum energy:**



- When two atoms approach to each other. Nucleus of one atom attracts the electron of another atom.
- According to quantum theory when two atoms of element approach each other then there will be force of attraction as well as force of repulsion between the bonded atoms. At the minimum distance where these forces become equal is called bond formation condition (equilibrium state) and atoms of the elements get stabilized by bond formation phenomena by lowering their energy.
- If net result is attraction, the total energy of the system (molecule) decreases and a chemical bond forms.
- So, Attraction  $\propto 1/\text{energy} \propto$  Stability.
- Bond formation is an exothermic process.

**Tendency to acquire noble gas configuration:**

- Atom combines to acquire noble gas configuration.
- Only outermost electron i.e.  $ns$ ,  $np$  and  $(n-1)d$  electrons participate in bond formation.
- Inert gas elements do not participate, as they have stable electronic configuration and hence minimum energy. (Stable electronic configuration :  $1s^2$  or  $ns^2np^6$ )

### 03. Lewis Octet Rule

- (i) Every atom has a tendency to complete its octet.
- (ii) Hydrogen has the tendency to complete its duplet.
- (iii) To acquire inert gas configuration atoms lose or gain electron or share electron.
- (iv) The tendency of atoms to achieve eight electrons in their outer most shell is known as Lewis octet rule.

### 04. Exception of Octet Rule :

- (i) **Incomplete octet molecules : or ( electron deficient molecules) or Hypovalent molecules**

Compound in which octet is not complete in outer most orbit of central atom.

Example – Halides of IIIA groups,  $\text{BF}_3$ ,  $\text{AlCl}_3$ ,  $\text{BCl}_3$ , hydride of III A/13<sup>th</sup> group etc.

- (ii) **Expansion of octet or (electron efficient molecules) or Hypervalent molecules**

Compound in which central atom has more than 8 electron in outermost orbits.

Example –  $\text{PCl}_5$ ,  $\text{SF}_6$ ,  $\text{IF}_7$ , the central atom P, S and I contain 10, 12, and 14 electrons respectively.

- (iii) **Pseudo inert gas configuration :**

Cations of transition metals, which contains 18 electrons in outermost orbit

Example :  $\text{Ga}^{+3}$ ,  $\text{Cu}^+$ ,  $\text{Ag}^+$ ,  $\text{Zn}^{+2}$ ,  $\text{Cd}^{+2}$ ,  $\text{Sn}^{+4}$ ,  $\text{Pb}^{+4}$  etc.

Electronic configuration of Ga –  $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^{10}, 4s^2 4p^1$

Electronic configuration of  $\text{Ga}^{+3}$  –  $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^{10}$

$\underbrace{\hspace{10em}}_{18 \text{ electron}}$

- (iv) **Odd electron molecules :**

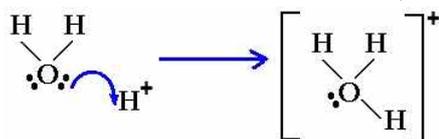
Central atom have an unpaired electron or odd number (7 electron, 11 electron, etc) of electrons in their outer most shell.

Example :  $\text{NO}$ ,  $\text{NO}_2$ ,  $\text{ClO}_2$ ,  $\text{ClO}_3$  etc.

e.g.,  $\text{NO}$  molecule

### 05. CO – ORDINATE BOND (DATIVE BOND)

- (i) It is a covalent bond in which the shared electron pair come from one atom is called coordinate bond.
- (ii) Necessary conditions for the formation of co-ordinate bond are-
  - (a) Octet of donor atom should be complete and should have at least one lone pair of electron.
  - (b) Acceptor atom should have a deficiency of at least one pair of electron.



- Atom which provide electron pair for sharing is called donor.
- Other atom which accepts electron pair is called acceptor. That is why it is called donor-acceptor or dative bond.

## 06. Covalent Bond :

- A covalent bond is formed by the mutual sharing of electrons between two atoms to complete their octet. (Except H which completes its duplet).
- The shared pair of electrons should have opposite spins, and are localised between two atoms concerned.
- Shairing of electrons may occurs in three ways –

No. of electrons shared between two atoms	Electron pair	Bond
2	1	Single bond (—)
4	2	Double bond (==)
6	3	Triple bond (≡)

## 07. Orbital concept of covalent bond :

- One orbital can accommodate at the most 2 electrons with opposite spins  $\uparrow\downarrow$
- Half filled orbital or unpaired electron orbital accepts one electron from another atom, to complete its orbitals.
- Tendency to complete orbital or to pair the electron is an essential condition of covalent bond. Completion of octet is not the essential condition of covalent bond.
- Covalency** : It is defined as the number of electrons contributed by an atom of the element for shairing with other atoms to achieve noble gas configuration.
- If the outermost orbit has empty orbitals then covalent bonds are formed in excited state.

## 08. Valence Bond Theory

The main points of theory are –

- To form a covalent bond overlapping occurs between half filled valence shell orbitals of the two atoms.
- Resulting bond acquires a pair of electrons with opposite spins to get stability.
- Orbitals come closer to each other from the direction in which there is maximum overlapping.
- So covalent bond has directional character.
- Extent of overlapping  $\propto$  strength of chemical bond.
- Extent of overlapping depends on two factors.
  - Nature of orbitals – p, d and f are directional orbitals  $\rightarrow$  more overlapping
  - s-orbitals  $\rightarrow$  non directional – less overlapping.