CONCEPT MAP

CHEMICAL BONDING AND MOLECULAR STRUCTURE

The attractive force which holds together the constituent particles in a chemical species is known as chemical bond.

Reason for combination of atoms

The atoms tend to adjust the arrangement of their electrons in such a way that they achieve eight electrons in their outermost shell. This is known as octet rule [given by Kossel-Lewis in 1916].

Exceptions of octet rule :

- **Incomplete octet**
  - $LiCl$ (2 electrons)
  - BeH_2 (4 electrons)
  - BF_3 (6 electrons)
- **Extended octet**
  - PCl_5 (10 electrons)
  - SF_6 (12 electrons)
  - IF_7 (14 electrons)

Combination of atoms

- By complete transfer of electrons
  - **Ionic bonding**
    The electrostatic force of attraction which holds the oppositely charged ions together is known as ionic bond.
- By sharing of electrons
  - Shared electrons given by only one atom
    - **Coordinate bond**
      Covalent bond in which both electrons in the shared pair come from one atom is called coordinate bond or donor-acceptor bond.
  - Shared electrons given by both atoms.
    - **Covalent Bonding**
      The bond formed by mutual sharing of electrons between the combining atoms of the same or different elements.
      - **Polar :** Between two atoms of different electronegativity.
      - **Non-polar :** Between two atoms of same electronegativity.

Overlapping of atoms

VBT (Valence Bond Theory)

- By Heitler and London (1927).
- Basic assumptions are
  (i) The bond is formed by using valence electrons only.
  (ii) Spherical orbitals (*s*-orbitals) do not show any preference in direction while non-spherical orbitals (*p*-and *d*-orbitals) tend to form bond in the direction of maximum overlap.

Hybridisation

The process of intermixing of the orbitals of slightly different energies so as to redistribute their energies resulting in the formation of new set of orbitals of equivalent energies and shapes.

MOT (Molecular Orbital Theory)

- By F. Hund and R.S. Mulliken (1932).
- Basic assumptions :
  (i) Molecular orbitals are formed by the combination of atomic orbitals.
  (ii) The number of molecular orbitals formed is equal to the number of atomic orbitals combined.
  (iii) When two atomic orbitals combine they form one bonding molecular orbital of lower energy and one anti-bonding molecular orbital of high energy.
  (iv) Electrons fill according to Aufbau's principle.

Hydrogen bonding

The attractive force which binds hydrogen atom of one molecule with electro-negative atoms (F, O or N) of another molecule is known as hydrogen bond.

- **Intermolecular hydrogen bond**
  Between two different molecules of the same or different substances.
  e.g. alcohol, water, HF.
- **Intramolecular hydrogen bond**
  Between the H atom and the highly electro-negative atom (F,O,N) present in the same molecule.
  e.g. *o*-nitrophenol.

Hybridisation

- ***sp* hybridisation**
  Shape : Linear
  Examples: $BeCl_2$, C_2H_2,
  Bond angle : 180°
- **sp^2 hybridisation**
  Shape : Trigonal planar
  Examples: BCl_3, C_2H_4,
  Bond angle : 120°
- **sp^3 hybridisation**
  Shape : Tetrahedral
  Examples :
  CH_4(Bond angle : 109°28′)
  NH_3(Bond angle : 107°)
  H_2O (Bond angle : 104.5°)
- **sp^3d hybridisation**
  Shape : Trigonal bipyramidal
  Examples : PF_5, PCl_5
  Bond angles : 120° and 90°
- **sp^3d^2 hybridisation**
  Shape : Octahedral
  Examples : SF_6, UF_6, TeF_6
  Bond angle : 90°
- **sp^3d^3 hybridisation**
  Shape : Pentagonal bipyramidal
  Examples : IF_7, XeF_6
  Bond angles : 72° and 90°