

BONDS IN SOLIDS AND LIQUIDS

1. Metallic Bonds

In metal atoms valence electrons move freely from the empty orbitals of one atom to another. These electrons that can move freely around the nuclei of the atoms form an "electron sea". An attraction force occurs between the negatively charged "sea of electrons" and the positively charged nuclei. Metal atoms are held together because of this attractive force. This is called the metallic bond.



- One valence electron in 3s orbital freely move in 3p orbital of another atoms.
- In a group, metallic bond strength generally decreases from up to down.
- In a period, strength generally increases from left to right
- Metals are good conductors of heat and electricity.
- Metals can be drawn into wires and hammered into shape easily.

Example 1

Compare the metallic bonds in Na, Mg and Al and explain.

2. Ionic Solids

- When metal and nonmetal atoms come together, they form ionic bonds.
- Electrostatic attraction occurs between the positive and negative charges holding the ions together.
- Metal ions are surrounded by nonmetal ions and nonmetal ions surrounded by metal ions.
- The melting and boiling points of ionic solids are very high.
- In molten state and in solutions they conduct electricity.

3. Network Solids

- Network solids are giant arrangements of matter in which atoms are covalently bonded together in a continuous two or three dimensional array. You can think of network solids as giant molecules.
- Graphite, diamond, SiC and SiO₂ are some examples.

Diamond

- Each carbon atom is covalently bonded to four others with sp³ hybrid orbitals forming a tetrahedral shape.
- It is the hardest substance known.
- It does not have free electrons. Thus it cannot conduct electricity.

Graphite

- Carbon atoms are bonded to three others with sp² hybrid orbitals forming hexagonal shapes with 120° angle.
- It is soft substance known.
- It can conduct electricity.

4. Dipole-Dipole Forces

- In polar covalent substances, there is an attraction between the positive end of one dipole and the negative end of neighboring dipoles. This attraction is called dipole-dipole attraction.

5. Van Der Waals Forces

- In noble gases and non polar molecules movement of electrons causes in non polar molecules becoming temporarily polar and an instantaneous dipole is formed. Momentarily dipole molecule causes neighboring molecules to become polar. Thus a weak attraction occurs between the molecules. This attraction is called Van der Waals Forces.
- It depends upon the electron density of the atoms. It is stronger between molecules with high molecular masses.

Example 2

Compare the boiling points of CH₄, H₂, N₂, O₂ gases.

6. Hydrogen Bonds

- F, O, and N are the most electronegative elements. Therefore their compounds with hydrogen (HF, H₂O and NH₃) are highly polar. This causes an attraction force stronger than usual dipole-dipole forces. This stronger intermolecular forces are called hydrogen bonds.
- Unexpected increase in the boiling points of HF, H₂O and NH₃ can be explained by hydrogen bond.