

GRADE 11 STUDY GUIDE | 2025

Chemical Bonding and Matter

Physical Sciences

1. Types of Chemical Bonding

Ionic Bonding

Formed between a METAL and a NON-METAL. Electrons are TRANSFERRED from metal to non-metal. Results in the formation of positive (cation) and negative (anion) ions held together by electrostatic attraction.

- High melting/boiling points (strong lattice forces)
- Conducts electricity when dissolved in water or melted
- Hard but brittle

Covalent Bonding

Formed between two NON-METALS. Electrons are SHARED between atoms.

- Single bond: 1 pair of electrons shared (e.g. H-H, H-Cl)
- Double bond: 2 pairs of electrons shared (e.g. O=O, C=O)
- Triple bond: 3 pairs of electrons shared (e.g. N triple N)
- Electronegativity difference determines polarity of bond

Metallic Bonding

METAL cations in a "sea" of delocalised electrons. Explains why metals conduct electricity, are malleable and ductile, and have high melting points.

2. Electronegativity and Polarity

$$\Delta(\text{EN}) = |\text{EN}_1 - \text{EN}_2|$$

< 0.5: non-polar covalent

0.5 to 2.1: polar covalent

> 2.1: ionic

In a POLAR COVALENT bond, the more electronegative atom attracts the shared electrons more strongly, resulting in partial charges (δ^+ and δ^-).

3. Molecular Shape (VSEPR Theory)

Valence Shell Electron Pair Repulsion: electron pairs (bonding + lone pairs) arrange to MINIMISE repulsion.

- 2 bonds, 0 lone pairs: LINEAR (180 deg) -- e.g. CO₂, BeCl₂

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- 3 bonds, 0 lone pairs: TRIGONAL PLANAR (120 deg) -- e.g. BF₃
- 4 bonds, 0 lone pairs: TETRAHEDRAL (109.5 deg) -- e.g. CH₄
- 3 bonds, 1 lone pair: TRIGONAL PYRAMIDAL (~107 deg) -- e.g. NH₃
- 2 bonds, 2 lone pairs: BENT/V-SHAPED (~104.5 deg) -- e.g. H₂O

4. Intermolecular Forces vs Intramolecular Forces

INTRAMOLECULAR: forces WITHIN a molecule (bonds). Breaking these requires very high energy.

INTERMOLECULAR: forces BETWEEN molecules. These determine physical properties.

- London/dispersion forces: weakest; present in ALL molecules; caused by temporary dipoles; stronger in larger molecules
- Dipole-dipole forces: in polar molecules; stronger than London forces for similar-size molecules
- Hydrogen bonding: strongest intermolecular force; occurs when H is bonded to N, O or F; explains high boiling points of water, HF, NH₃

KEY: Higher IMF strength => higher boiling point, higher viscosity, lower vapour pressure, lower solubility in non-polar solvents.

5. Ideal Gas Law

$$pV = nRT$$

$$p_1V_1/T_1 = p_2V_2/T_2 \text{ (for fixed amount of gas)}$$

Where: p in Pa, V in m³, T in Kelvin (K = degC + 273), n in mol, R = 8.314 J.mol⁽⁻¹⁾.K⁽⁻¹⁾

- Boyle's Law: $p_1V_1 = p_2V_2$ (T constant)
- Charles' Law: $V_1/T_1 = V_2/T_2$ (p constant)
- Gay-Lussac's Law: $p_1/T_1 = p_2/T_2$ (V constant)