AP CHEMISTRY CHEAT SHEET

Unit 3 : INTERMOLECULAR FORCES & PROPERTIES

Quick Overview

- **Focus:** intermolecular forces (IMFs), phase changes, solubility, and properties of liquids and solids.
- **Exam Lens:** connect molecular polarity → type of IMF → observed property (boiling point, vapor pressure, etc.).

Types of Intermolecular Forces

1. London Dispersion Forces (LDF)
- Weakest IMF; present in all molecules.
- Strength ↑ with molar mass and surface area.
- Temporary dipoles due to electron movement.
- Example: $I_2 > Br_2 > Cl_2 > F_2$ (increasing strength).

2. Dipole–Dipole Forces
- Between polar molecules with permanent dipoles.
- Greater dipole moment → stronger attraction.

3. Hydrogen Bonding (H-bonding)
- Special dipole interaction: H bonded to N, O, or F.
- Strongest IMF among covalent molecules.
- Responsible for high boiling point of H_2O, HF, NH_3.

4. Ion–Dipole Forces
- Between ions and polar molecules (e.g., Na^+ in water).
- Strength depends on ion charge and dipole magnitude.

Mnemonic: “London → Dipole → H-bond → Ionic” (weak → strong).

Forces & Properties

- Stronger IMFs → higher boiling point (more energy needed to separate molecules).
- Stronger IMFs → higher melting point (particles held more tightly).
- Stronger IMFs → higher viscosity (liquid flows more slowly).
- Stronger IMFs → higher surface tension (molecules pulled tightly at surface).
- Stronger IMFs → lower vapor pressure (fewer molecules escape into gas phase).
- For two substances at the same temperature → the one with weaker IMFs evaporates faster.

Mnemonic: “IMFs climb, vapor pressure dives.”

States of Matter

- **Solids:** particles fixed in place; definite shape & volume.
- **Liquids:** particles close but can move; definite volume, no fixed shape.
- **Gases:** free motion; expand to fill container.
- IMF strength determines state at given temp.

Common exam pitfalls

- **Confusing bond strength (intramolecular) with IMF strength (intermolecular).**
- **Forgetting hydrogen bonds only occur with N, O, or F.**
- **Mixing up vapor pressure and boiling point.**
- **Forgetting network solids have covalent bonds, not IMFs.**

Solubility & Miscibility

- **Like dissolves like:** polar dissolves polar; nonpolar dissolves nonpolar.
- Ion–dipole interactions explain solubility of salts in water.
- Network solids (diamond, SiO_2) are insoluble and nonconductive.

Vapor Pressure & Boiling Point

- **Vapor pressure:** pressure from molecules escaping liquid phase.
- **Boiling point:** temperature where vapor pressure = external pressure.
- **Inverse relationship:** stronger IMFs → lower vapor pressure, higher boiling point.

Mini formula box

$$\ln(P_1/P_2) = -(\Delta H_{vap} / R) \times (1/T_1 - 1/T_2)$$

Phase Diagrams

- Show phases as a function of temperature and pressure.
- **Triple point:** all 3 phases coexist.
- **Critical point:** above this, liquid/gas distinction vanishes.
- Water’s slope of solid–liquid line is negative (ice less dense than liquid water).

Solids & Crystal Types

1. **Ionic:** high melting, brittle, conductive when molten (NaCl).
2. **Molecular:** low melting, poor conductors (CO_2, I_2).
3. **Metallic:** variable melting, conductive, malleable.
4. **Network Covalent:** very high melting, hard (C, SiO_2).

Chromatography & IMF

- Used to separate substances based on polarity.
- Polar stationary phase → polar substances travel slower.
- Nonpolar stationary phase → nonpolar substances travel slower.

Formula: Rf = distance solute / distance solvent front.

Vaporization & Energy

- $q = mC\Delta T$ (heating within phase)
- $q = n\Delta H_{vap}$ or $q = n\Delta H_{fus}$ (phase change)

Latent heat = energy required to break IMFs, not bonds.