

Notes 10-2: Intermolecular Forces, Melting & Boiling Points
Chemistry Honors

Concept 1: The strength of the coulombic attractions that hold particles of a substance together depends on the type of substance

- Covalent substances contain molecules or atoms that are attracted by intermolecular forces (IMFs)
 - IMFs are formed between dipoles, so are relatively weak **partial** charges
 - The strength of the dipoles depends on the **polarity** of the atom/molecule
 - Compounds containing H bonded to N, O, or F have strong dipoles and can form relatively strong **H-bonds**
 - Compounds containing weaker dipoles form relatively weaker **dipole-dipole** interactions
 - Nonpolar molecules and atomic elements (i.e. Noble gases) do not contain permanent dipoles and only form relatively weak **London Dispersion Forces (LDFs)**
 - ALL substances exhibit LDFs but they are generally significant only in the absence of stronger forces
 - LDFs can become significant as atom/molecule size increases due to increasing size of the electron cloud, which increases **polarizability**
 - Thus, a large nonpolar molecule may have stronger IMFs than a small molecule that exhibits H-bonding.
- Ionic compounds contain cations and anions that are attracted by ionic bonds
 - Ion-Ion attractions are strong because they consist of **full** charges
- Metallic substances contain metal cations that are attracted by delocalized electrons (metallic bonds)
 - Metallic bonds are strong because they consist of **full** charges
- In general, the order of increasing strength of inter-particle coulombic attractions is:
 - **LDF (Dispersion) < Dipole-Dipole < H-bonding < Metallic ≈ Ionic**
 - For metals and ionics there are large ranges that essentially overlap, and generalities are difficult to draw.

Concept 2: Melting and boiling require energy to break inter-particle coulombic attractions

- Stronger attractive forces require **more** energy
- Temperature measures **average kinetic energy** of particles
- More energy needed means **higher** temperatures
- Thus the relative strengths of inter-particle coulombic attractions of different substances can be used to predict their relative melting points (MP) and boiling points (BP)
 - MP & BP can be used to compare relative inter-particle forces

Comparison and Analysis of Two Molecules

- Acetone (CH_3COCH_3) and isopropanol ($\text{CH}_3\text{CHOHCH}_3$) are similar in size so have similar LDFs. Both are liquids at room temperature. Acetone has a BP of 56°C and isopropanol has a BP of 82.5°C . Draw a second molecule of each below, draw in any significant partial charges and determine the type of IMF in each to explain this difference. Draw one IMF for each molecule

