

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

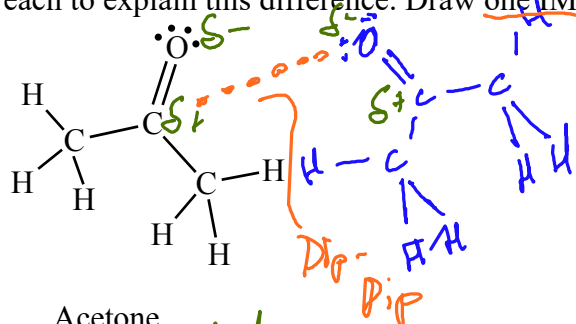
- Covalent substances contain molecules or atoms that are attracted by intermolecular forces (IMFs)
 - IMFs are formed between dipoles, so are relatively weak partial charges
 - The strength of the dipoles depends on the polarity of the atom/molecule
 - Compounds containing H bonded to N, O, or F have strong dipoles and can form relatively strong H-bonding
 - Compounds containing weaker dipoles form relatively weaker dip-dip interactions
 - Nonpolar molecules and atomic elements (i.e. Noble gases) do not contain permanent dipoles and only form relatively weak LDF-dispersion
 - 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 < Dip-Dip < H-bond < ionic ≈ metallic
 - 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 *endothermic*

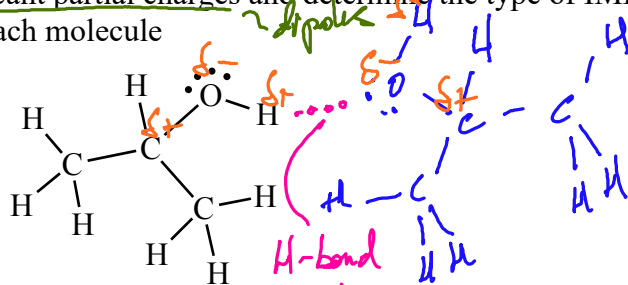
- Stronger attractive forces require more energy
- Temperature measures average kinetic energy of particles
- More energy needed means higher temperatures
- Thus the relative strengths of inter-particle coulombic attractions of different substances can be used to predict their relative melting points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



Acetone
C-H NTC - no dipoles
C-O PC
1.5 3.5



Isopropanol
Stronger IMF
• Need more energy to break
• Higher BP

C-H
C-O
O-H PC
3.5 2.1