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

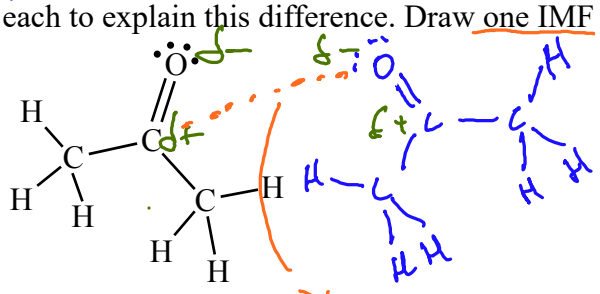
- Covalent substances contain molecules or atoms that are attracted by intermolecular forces (IMFs)
  - IMFs are formed between dipoles, so are relatively weak partial charges
  - The strength of the dipoles depends on the polarity of the atom/molecule
    - Compounds containing H bonded to N, O, or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

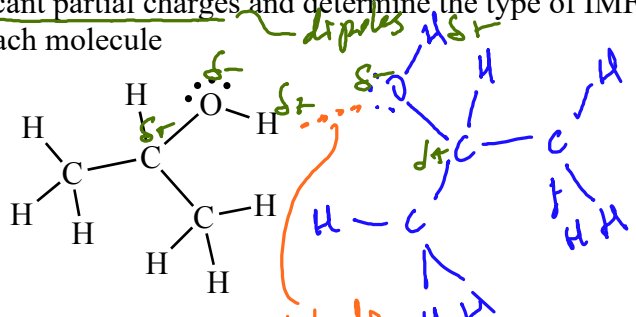
- Stronger attractive forces require more energy
- Temperature measures average kinetic energy of particles
- More energy needed means higher temperatures
- Thus the relative strengths of inter-particle coulombic attractions of different substances can be used to predict their relative melting points (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 ($CH_3CHOHCH_3$) 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



Isopropanol

C-H all NP
C-O 2.5 3.5 PC

Stronger IMF's
so More energy needed → higher BP

C-O PC
O-H PC