CHAPTER OVERVIEW

Chapter 5: Systems Thinking

Let us recap where we are with atoms, at least from a chemistry perspective:

- Atoms interact electrostatically with each other in a variety of ways, from transient interactions that result in weak (easy to overcome) attractions to strong (bonding) interactions that are much more difficult to break.
- When atoms interact they form more stable systems, where the attractive and repulsive interactions are equal. The potential energy of the system decreases but the total energy of the system remains constant. The total energy of the interacting atoms (the system) can decrease if it is transferred to the surroundings, usually by collisions with other molecules or atoms but the emission of a photon is also possible.
- Whether weak or strong, all types of interactions require energy to overcome. Typically this energy is derived from collisions with surrounding molecules, although absorption of a photon can also overcome interactions.
- The ways that atoms interact depend upon the arrangements of the electrons within them. Different types of atoms have different “internal” arrangements of electrons.
- When atoms bond to form new materials (compounds), the properties of those compounds are emergent—that is, they are quite different from the properties of the isolated component atoms.
- The macroscopic properties of materials depend upon the types of bonds present and their spatial organization, which influences molecular shape, the distribution of charges within the molecule, and intermolecular interactions.
- Some materials are continuous (diamond, metals, ionic compounds), whereas others are composed of discrete molecular units (water, methane, lipids, proteins).
- If you know the temperature at which phase changes occur in a material (solid to liquid, liquid to gas, etc.), you can make predictions about how much energy is required to overcome the interactions between the particles that make up the material.

Now we are ready to draw all these ideas together and make connections between the macroscopic and molecular levels. Understanding these connections allows us to predict how and when chemical changes will occur, which is the heart of chemistry.

Thumbnail: Flames of charcoal. (CC BY-SA 3.0; Oscar via Wikipedia)