Tutorial 11: Intermolecular Forces of Attraction and Heating Curves

Goals:

- ✓ To determine the intermolecular forces of attraction that exist between molecules.
- ✓ To be able to interpret a heating curve, and understand changes of state (melting and boiling).

Intermolecular Forces of Attraction

- Gases have no attractive forces for one another (or negligibly small attractive forces).

- Liquids and solids have significant attractive forces for one another. Whether the attractions are strong or weak depends on the type of attraction and the size of the molecules involved.

- **Intermolecular forces of attraction** refers to the forces of attraction that exist between molecules. Ionic compounds do not have intermolecular forces of attraction because they are not made up of molecules. Ionic compounds have ionic bonds (electrostatic forces), which are strong attractive forces between the oppositely charged ions.

- **Molecular compounds have intermolecular forces of attraction:**

  - **London Dispersion Forces:** Weak attractive force that result from the movement of electrons within molecules. The larger the molecule size the more electron density there is to shift around, and the more polarized it may become thus increasing the strength of the LDF.

  - **Dipolar Forces (dipole-dipole):** Attractive force between the partial positive charge of one dipole and the partial negative charge of another dipole.

  - **Hydrogen bonding:** Special type of dipolar attractive force that exists between a hydrogen atom and two highly electronegative atoms (O, N or F). Hydrogen bonding is not a covalent bond!

Change of State and Heating Curves

- **Solids:** In the solid state the intermolecular forces of attraction are at a maximum. This results in the molecules being locked in place (solid state).

- **Melting:** As heat is added to a solid the molecules will gain more and more kinetic energy. Eventually, the KE will be great enough to overcome some of the intermolecular forces of attraction that held the substance in the solid state, and the substance will melt into a liquid.

- **Liquids:** Liquids have fewer than the maximum number of intermolecular forces of attraction. This results in more freedom for the individual molecules to move around and flow (liquid state). Note that the molecules still have attractive forces for one another, just fewer than in the solid state.

- **Boiling:** As heat is added to a liquid the molecules will gain more and more kinetic energy. Eventually, the KE will be great enough to overcome all remaining intermolecular forces of attraction that held the substance in the liquid state, and the substance will boil into a gas.

- **Gases:** Ideal gases have no intermolecular forces of attraction for one another. All attractive forces have been overcome by the KE of the molecules.