Chapter 9 – Liquids and Solids

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- Evaporation – When molecules escape the surface of a liquid
- What happens in a closed container:
  1. Evaporation
  2. Condensation
- When the rate of evaporation equals the rate of condensation, equilibrium is reached.
- Vapor Pressure – Pressure at equilibrium of a liquid, specific to a liquid, which is the max amount of molecules a vapor can hold. If there are not enough molecules, all are in vapor. If there are too many, liquid and vapor is mixed.
- At High Vapor Pressure – Weak forces, which means a lot of gas molecules, which means it is volatile (evaporates quickly)
- At Low Vapor Pressure – Forces are strong, resulting in few gas molecules, which means it is nonvolatile (evaporates slowly)
- As temperature goes up, vapor pressure goes up
- Boiling Point – A liquid boils when it reaches the temperature at which the vapor pressure is equal to the pressure above it
- Decreasing external pressure causes decrease in boiling point (don't cook pasta at Tahoe)
- Critical Temperature – A temperature above which the liquid phase can not exist
- Critical Pressure – The pressure that must be applied to cause condensation at the critical temperature
- A phase diagram looks as follows:
- On the line between gas and solid is sublimation

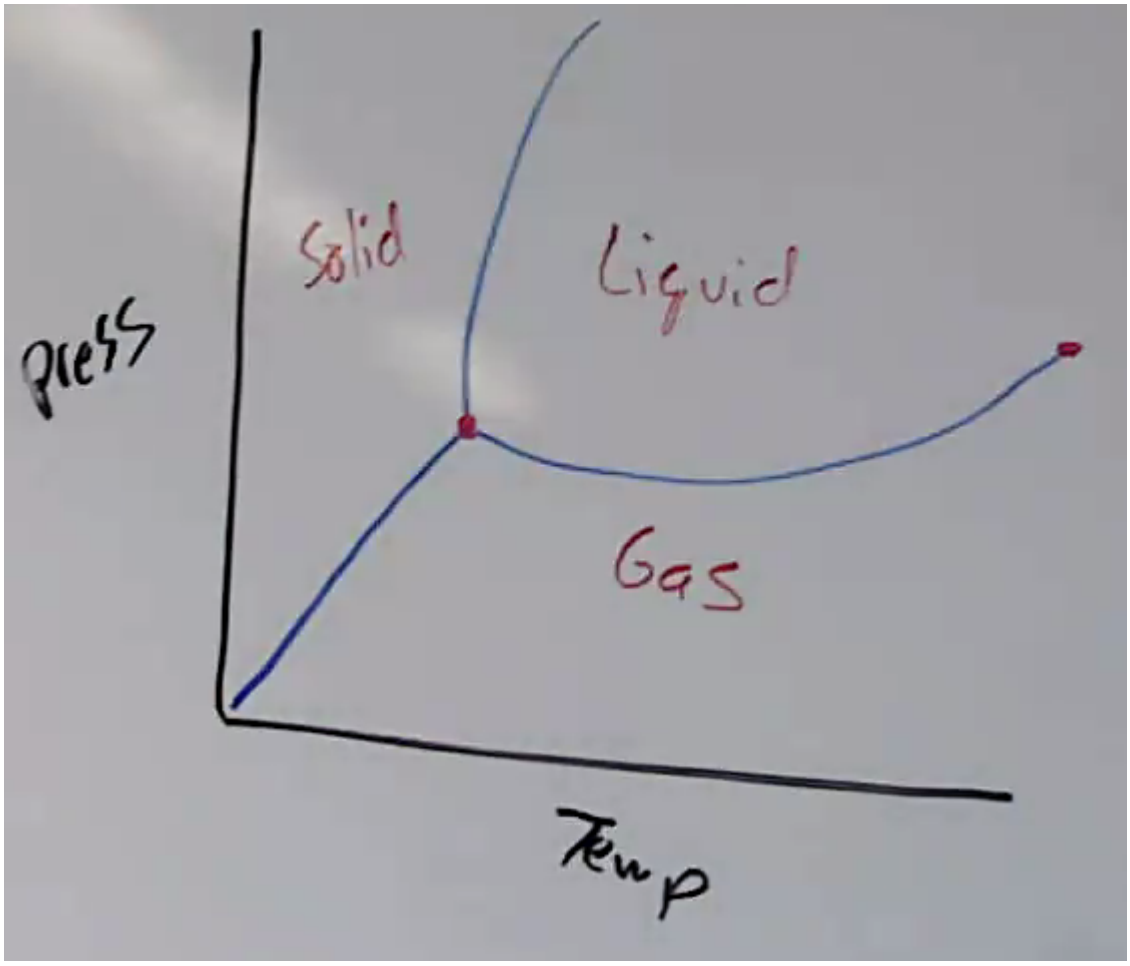

Figure 1: Phase Diagram Example

- Point in the middle is the triple point
- Between gas and liquid is boiling point line
- Melting/Freezing line is between solid and liquid
- Intramolecular forces (bonds)
    1. Covalent
    2. Polar Covalent
    3. Ionic
- Intermolecular Forces (Hold Molecules together)
    1. Hydrogen Bonding − H with an N, O, F: Strongest, highest melting and boiling points, but low vapor pressure.
    2. Dipole − Between polar molecules.
    3. Dispersion (London) − Between nonpolar molecules. Weakest of the three.

Example: Which has the weakest force, lowest melting, and highest vapor pressure?

- C_2H_3OH or $\underline{C_2H_6}$
- $CH_3CH_2CH_2OH$ or $\underline{CH_3OH}$
- H_2O or $\underline{CH_3OH}$
- $\underline{Ar_{54}}$ or NH_3
- $\underline{F_2}$ or Br_2
- NO or $\underline{O_2}$

For the AP Exam:

- If a molecule uses hydrogen bonding, it uses dipole and dispersion. If it uses Dipole, it uses dipole and london. If it uses london, it uses only london.
- Types of solids:
    1. Molecular − Uses one of the three intermolecular forces, low melting point, and non-conductive.
    2. Ionic − Made of ions, high melting point, conducts if dissolved in water.
    3. Network Covalent − Use intramolecular forces, very high melting point, nonconductive (C, Si, SiO).
    4. Metals − Use the electron sea diagram. Positive ions are held together in a mobile sea of electrons, and are very conductive.

- The lattice energy is a measure of the strength of the ionic bond. The smaller the ions, the closer they approach one another, the stronger the bond is.

  Example: Which has the highest boiling point?

- $\underline{Ca(OH)_2}$ or CH_3OH
- NaCl or $\underline{SiO_2}$
- $\underline{MgCl_2}$ or Cl_2