**Liquids and Solids**

What is the difference between a solid, a liquid, and a gas?

What happens when a substance melts?

What happens when a substance boils?

What does not happen when a substance undergoes a phase change?

Let's look at water:

$H_2O(s) \rightarrow H_2O(l)$ $\Delta H^\circ_{fusion} = 6.02$ kJ/mole

$H_2O(l) \rightarrow H_2O(g)$ $\Delta H^\circ_{vaporization} = 40.7$ kJ/mole

What determines the melting/boiling point of a substance

What are the differences between intermolecular and intramolecular forces?

Intermolecular Forces

1)

2)

3)

What do we mean by the term Van der Waals Forces?

London Dispersion Forces

The Halogen Family

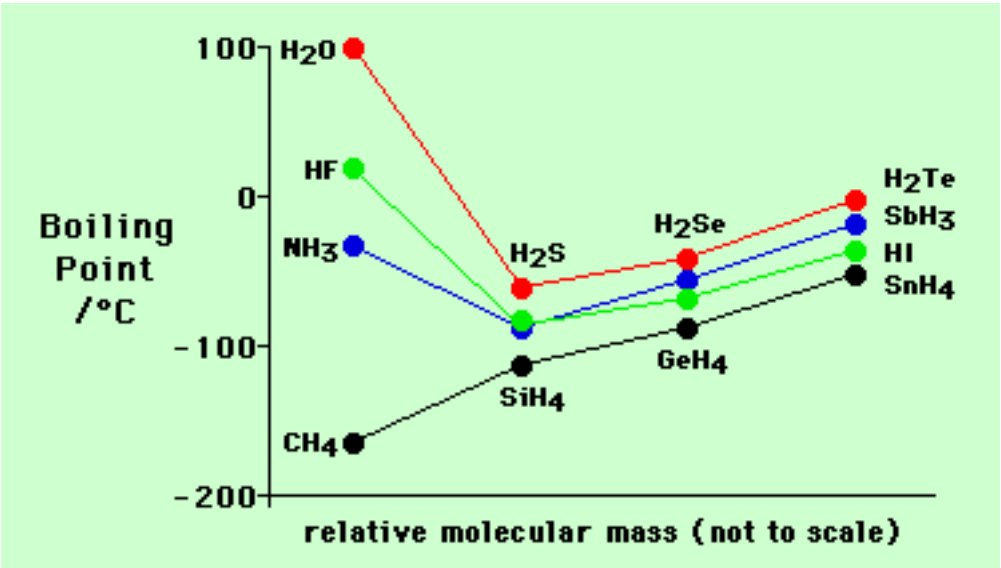
Dipole–Dipole Forces

The worst name in all of chemistry.

Hydrogen Bonding

What must the structure be like for hydrogen bonding to occur?

The Boling Points Graph



Structural Effects on Intermolecular Forces

$H_2O$

HF

$C_2H_5OH$

$CH_3OCH_3$

$CH_3COCH_3$

$CH_3CHO$

$C_5H_{12}$ (multiple isomers)

**What is a Liquid?**

Surface Tension

Capillary Action

Cohesive Forces

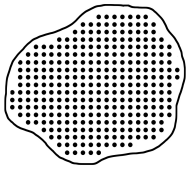
Adhesive Forces

Viscosity

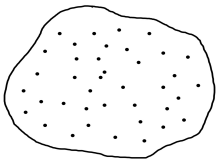
**What is a solid?**

**What are the different types of solids?**

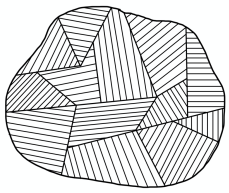
Crystalline



Amorphous



Polycrystalline



Some Examples of Solids:

| Substance | Examples | Particles Present | Major Inter-particle Forces |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

Properties of Crystalline Solids

Ionic

Molecular

Atomic

Metals

Metallic Bond

Electron Sea Model

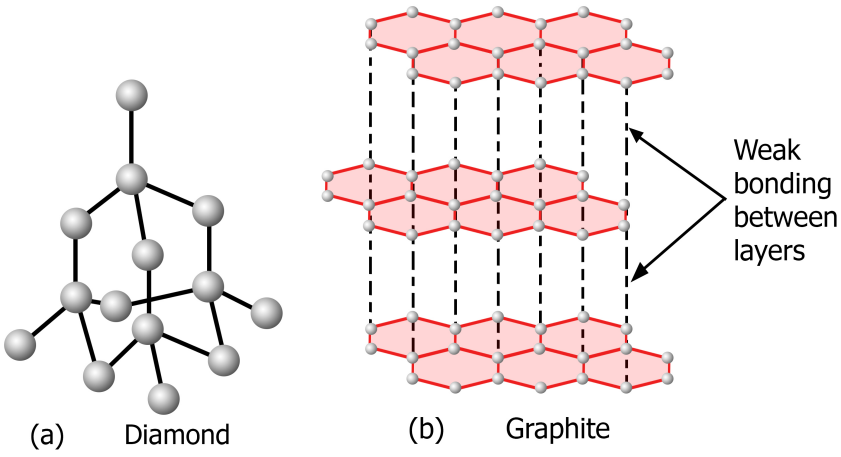
**Alloys**

Substitutional "Brass"

Interstitial "Steel"

Network Atomic Solids

Allotropes



**The Liquid State**

Vapor Pressure

Vapor Pressure and Intermolecular Forces

Vapor Pressure and Temperature (the Ice Cream Graph returns)

Change in State

**Measuring Vapor Pressure**

$H_2O(l) \rightarrow H_2O(g)$ $\Delta H^\circ_{vaporization} = 40.7$ kJ/mole

Barometers

Vapor Pressure as a function of temperature

Now graph it as a straight line

Clausius–Claperyon Equation

1) The vapor pressure of water at 10.0°C is 9.209 torr. The vapor pressure at 60.0°C is 149.4 torr. What is the heat of vaporization for water?

2) Find the vapor pressure of water at 50.0°C knowing that the heat of vaporization is 40.7 kJ/mole and using other common knowledge.

3) The atmospheric pressure on the summit of Mount Everest is 240 torr. What is the boiling point of water at this elevation if the heat of vaporization is 40.7 kJ/mole?

Heating Curves

Normal Boiling Point

*The temperature at which the vapor pressure of the liquid is exactly one atmosphere.*

Normal Melting Point

*The temperature at which the solid and the liquid states have the same vapor pressure under conditions where the total pressure is one atmosphere.*

**Phase Diagrams**

For Water!

For Carbon Dioxide and everything else.

Critical Temperature

*The temperature above which the vapor cannot be liquefied no matter what pressure is applied.*

Critical Pressure

*The pressure required to produce liquefaction at the critical temperature*

Critical Point

Triple Point

Super Cooling and Super Heating

| **Location** | **Altitude (feet)** | **Atmospheric Pressure (torr)** | **Boiling Point of Water** |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |