Intermolecular and Intramolecular Interactions

1. Define

   a. Intramolecular Interactions

      Interactions (bonds) *within* a molecule.

   b. Intermolecular Interactions

      Interactions *between* two or more particles.

2. How do intermolecular Interactions affect the boiling and freezing point of a substance?

   Increased interactions results in a higher boiling point and higher freezing point.

3. Why is ΔH_{vap} much greater than ΔH_{fus} ?

   Because liquid → gas transition breaks virtually all of the intermolecular bonds.

4. Types of Intramolecular Bonds and an example of each

   a. Non-polar (O_2)

   b. Polar covalent (HF)

   c. Ionic (NaCl)

   d. Atomic ($C_{graphite}$)

5. Types of Intermolecular Interactions

   a. London Dispersion (aka Van Der Waal's forces or LDF)

i. What type of substances experience this type of interaction?

All polar and non-polar substances.

ii. What occurs to make this interaction happen?

Shift of e^- to one side.

iii. What affects the strength of this interaction?

The size of the atom/molecule.
increased mass = increased strength

iv. What evidence suggests this type of interaction exists?

The fact that non-polar substances can be condensed to liquids and solids.

b. Dipole-Dipole Interactions

i. What type of substances experience this type of interaction?

Polar covalent substances.

ii. What occurs to make this interaction happen?

Dipoles line up due to attraction of partial charges.

iii. What affects the strength of this interaction?

The greater the polarity the greater the strength.

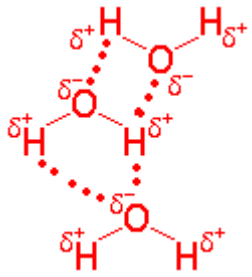
c. Hydrogen bonding (a special type of dipole-dipole interaction)

i. What type of substances experience this type of interaction?

Substances with polar N-H, O-H or H-F bonds.

ii. What occurs to make this interaction happen?

Dipoles line up due to attraction. This type of dipole is stronger than the typical dipole-dipole interaction because F, O and N are particularly electronegative.



iii. What affects the strength of this interaction?

The more polar the bond and greater the number of N-H, H-F or O-H bonds, the stronger the interaction.

d. Ionic

i. What type of substances experience this type of interaction?

Ionically bonded substances.

ii. What occurs to make this interaction happen?

Positively and negatively charges line up.

$Na^+Cl^-Na^+Cl\text{-}Na^+Cl^-$ etc….

e. What is the typical ordering of strength for these interactions? Are there situations where this ordering may not apply?

Ionic > Hydrogen Bond>Dipole-Dipole>London Dispersion

There are occasions when this order may not apply. A very large non-polar substance compared to a mildly polar compound may have an LDF that is stronger than the dipole-dipole interaction.

6. Identify the most important types of interparticle forces present in the solids of each of the following:

a. NH_4Cl

Ionic compund – ionic interactions

b. Ar

Atom – LDF only

c. HF

Polar – Hydrogen bonding and LDF

d. BF_3

Non-polar - LDF

e. $CHCl_3$

Polar – dipole-dipole and LDF

7. For which molecule in each of the following pairs would you expect the stronger intermolecular forces?

a. $CH_3CH_2CH_2NH_2$ or $H_2NCH_2CH_2NH_2$

The answer has 2 areas of hydrogen bonding capability.

b. CH_3CH_3 or H_2CO

The answer is polar so it has dipole-dipole interactions.

c. CH_3OH or H_2CO

Though both are polar, the answer is polar with the ability to hydrogen bond.

d. HF or HBr

Once again, both options are polar, but HF has the ability to hydrogen bond.