Unit seven reader (Chapter 11 and 13)

This chapter deals with intermolecular forces in liquids, solids, and gasses. The majority of time will be spent on liquids.

Intramolecular forces are the attractive forces within molecules. These forces are generally referred to as covalent bonds. These forces give molecules their chemical properties.

Intermolecular forces are forces that exist between molecules. These forces determine the physical properties of liquids and solids.

The physical state of a substance depends on the balance of the kinetic energy (temperature) of the molecules and the attractive forces between the molecules themselves. This is why the state of the substance can be determined by knowing its temperature. These forces determine the boiling point and melting point of the substance.

In general, as the intermolecular force increases the melting and boiling point also increase. Why?

There are three and a half types of intermolecular forces. Make sure you understand each.

Ion-dipole forces- This is exactly what it sounds like, it is an attraction between an ion and a polar molecule. A common example is salt in water. The polar water molecules are attracted to the sodium and chlorine ions.

Dipole-dipole forces- Once again this is exactly what it sounds like, it is an attraction between two polar substances.

London dispersion forces - are forces created by induced dipoles in non-polar substances. LDF's occur when the positively charged nucleus of one atom induces a temporary dipole by attracting the electrons from a neighboring atom. This results in a negative charge on one side of the molecule and a positive charge on the other. These forces exist in all substances and are the weakest of all the intermolecular forces. *In general dispersion forces tend to increase with increasing molar mass.* Draw an illustration of a molecule experiencing LDF's.-

Hydrogen bonding is a very strong form of dipole-dipole bonding. Hydrogen bonding exists only between hydrogen atoms bonded to F, O, and N. Hydrogen bonding accounts for the unique properties of water.

To determine what type of IMF is dominant check the type of bonds involved, if there is an ionic and a polar substance the IMF will be Ion-dipole. If they are both polar it will be dipole-dipole, and if there are only non-polar substances it will be dispersion forces.

Example- Describe the IMF for each of the following molecules

CH_3OH

NH_3

H_2S

CH_4

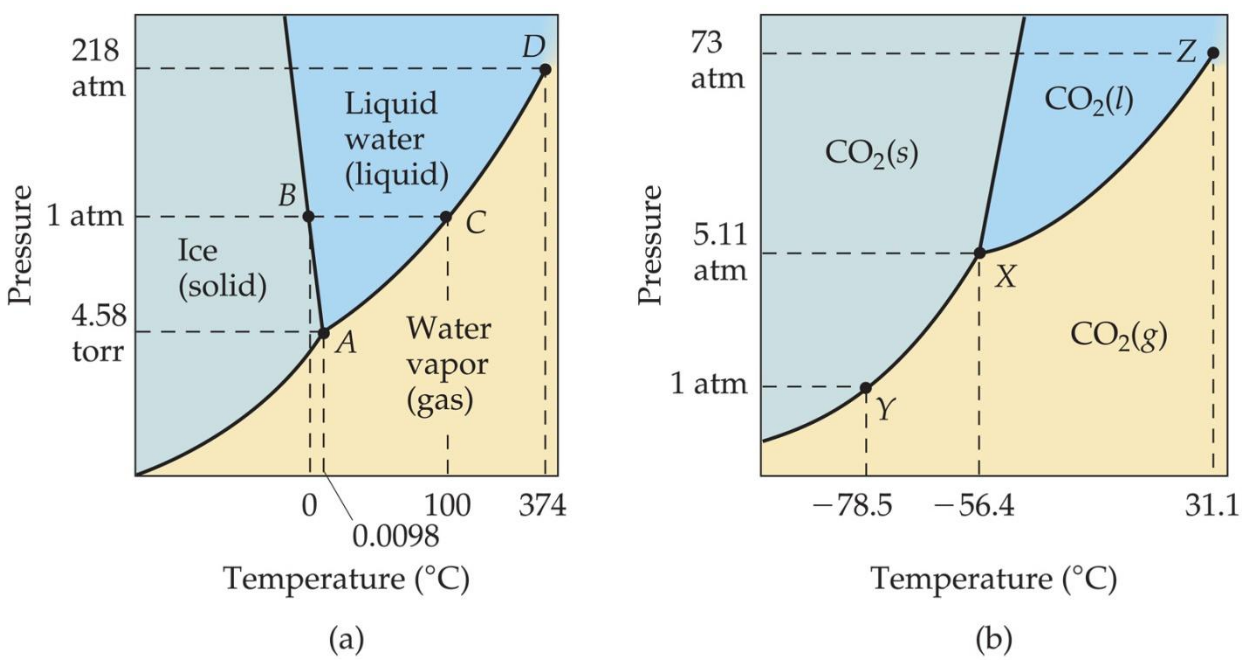
Sections 11.3 and 11.4 should be read and qualitatively understood.

Vapor pressure- as discussed last chapter vapor pressure is the pressure of a gas above a liquid. Liquid substances of low molar mass and weak IMF tend to have high vapor pressures. Why?

Increasing temperature will increase vapor pressure. Why?

Boiling point is when the vapor pressure of the liquid matches the atmospheric pressure.

Phase diagrams- show the relationship between temperature, pressure, and the state of matter the substance is in. The lines represent the boiling and melting points under given conditions.



The phase diagrams for water and carbon dioxide should be understood.

The **triple point** is the point at which all three states of matter can exist in equilibrium.

Why do we never find liquid carbon dioxide in nature?

Describe the irregularities on the water phase diagram-

Chapter 13-Properties of solutions-

The first three sections are review from last year and should be read and understood, but will not be covered in class.

There are five quantitative ways to express concentrations ALL five are important.

Mass percent- $\frac{\textit{mass of solute}}{\textit{mass of soultion}} * 100$

Parts per million- $\frac{\textit{milligrams of solute}}{\textit{kilograms of solution}}$

Mole fraction $\frac{\textit{moles of one component}}{\textit{total moles of all components}}$

Molarity $\frac{\textit{moles of solute}}{\textit{Liters of solution}}$

Molality $\frac{\textit{moles of solute}}{\textit{Kilograms of solvent}}$

Examples-

a- Enough water is added to 11.5 grams of ethanol to make 2.00 liters of solution. What is the molarity of the ethanol?

b- What is the mole fraction of water in a solution that contains 24 grams of methanol in 36 grams of water?

c- How many grams of sugar need to be added to water to create 250g of a 32% sugar water solution? How much water is there to begin with? If the final volume of the solution is 224 ml, what is the density of the solution?

d- 45 grams of NaCl solid is added to water to make 2 L of solution. What is the molarity AND the molality? What is the density of this solution

e- 200 L of automobile exhaust was analyzed and found to contain .085 grams of arsenic. What is the ppm of arsenic in the sample. The density of the gas is 1.145 g/l

f- You are asked to prepare a .25 molar solution of $AgNO_3$. How would you prepare the solution?

Colligative properties-

Colligative properties are physical properties of solutions that depend only on the amount of solute particles present in the solution and not on the identity of the solute.

There are three main colligative properties and one minor one

1**- Vapor pressure lowering**- *a solution has a lower vapor pressure than the pure solvent*. Why?

2- **Boiling point elevation**- *the boiling point of a solution is higher than the pure solvent*. Why?

3- **Freezing point depression**- *the freezing point of a solution is lower than the pure solvent*. Why?

4- **Osmotic pressure** is the fourth colligative property and is simply the pressure required to stop osmosis. Osmosis is the net movement of solvent through a semi-permeable membrane toward a solution of higher concentration. This is all that needs to be known about osmosis and osmotic pressure.

Quantitative rules for colligative properties-

Raoult's Law

$$P_A = X_A P°_A$$

where

- X_A is the mole fraction of compound A
- $P°_A$ is the normal vapor pressure of A at that temperature

NOTE: This is one of those times when you want to make sure you have the vapor pressure of the *solvent*.

Calculate the vapor pressure of water above a solution prepared by adding 22.5 grams of lactose $C_{12}H_{22}O_{11}$ to 200 grams of water at 338K. $P_{(H20)}$ = 187.5 torr

Boiling Point Elevation

Solvent	Normal Boiling Point (°C)	K_b (°C/m)	Normal Freezing Point (°C)	K_f (°C/m)
Water, H_2O	100.0	0.51	0.0	1.86
Benzene, C_6H_6	80.1	2.53	5.5	5.12
Ethanol, C_2H_5OH	78.4	1.2	−114.6	.99
Carbon tetrachloride, CCl_4	76.8	5.02	−22.3	29.8
Chloroform, $CHCl_3$	61.2	3.6	−63.5	.68

The change in boiling point is proportional to the molality of the solution:

$$\Delta T_b = K_b \cdot m$$

where K_b is the molal boiling point elevation constant, a property of the solvent.

ΔT_b is *added to* the normal boiling point of the solvent.

Freezing Point Depression

Solvent	Normal Boiling Point (°C)	K_b (°C/m)	Normal Freezing Point (°C)	K_f (°C/m)
Water, H_2O	100.0	0.51	0.0	1.86
Benzene, C_6H_6	80.1	2.53	5.5	5.12
Ethanol, C_2H_5OH	78.4	1.2	−114.6	.99
Carbon tetrachloride, CCl_4	76.8	5.02	−22.3	29.8
Chloroform, $CHCl_3$	61.2	3.6	−63.5	.68

- The change in freezing point can be found similarly:

$$\Delta T_f = K_f \cdot m$$

- Here K_f is the molal freezing point depression constant of the solvent.

ΔT_f is *subtracted from* the normal freezing point of the solvent.

Using data from table 13.4, calculate the freezing and boiling points of each of the following solutions-

a- .22 m glycerol (C3H8O3) in ethanol

b-2.04 g of KBr in 188 grams of water.

Example-

175 grams of calcium chloride are dissolved in 975 grams of water. The density of the resulting solution is 1.10 g/ml.

a- What is the vapor pressure of the solution at 298 K C? The vapor pressure of water at 298 K is 23.76 torr.

b- At what temperature will the solution freeze? The freezing point constant for water is 1.86 C /m

c- At what temperature will the solution boil? The boiling constant for water is .51 C/m

Test- This test will be 15 multiple choice questions and two free response. The free response from chapter 11 will be qualitative and the question from chapter 13 will be quantitative and be primarily from the ways of expressing concentration section.