Chapter 10 Notes
Combined gas law-
A useful tool to solve for changes in a fixed gas is the combined gas law. It says that the changes in a fixed gas can be calculated by the following relationship-

$P_1V_1/T_1 = P_2V_2/T_2$

This is commonly used to find the new pressure or volume when the temperature or volume has been changed. It is an easy mathematical relationship to use and to memorize.

Example- A child releases a balloon containing 3.5 L of He at 25 C and 761 torr. What would be the volume of the balloon when it rises to an altitude where the temperature is 11 C and the pressure is 685 torr?

Understanding and using the Ideal gas law-

The power of the IGL is the ability to use it in stoichiometric equations.

$PV = nrt$

In the PV = nRT, n is the number of moles of the gas. Knowing the number of moles can then be used in a stoichiometric equation. Remember stoichiometry is finding the value of a desired substance given information about another by using the coefficients in a balanced chemical equation. Here is an example-

How many liters of CO_2 are produced at 25 C and 712 torr when 1 gallon of gasoline, C_8H_{18} is burned in excess air? The density of C_8H_{18} is.690 g / ml. One gallon is 3.80 L.

We would first need to balance this equation-

Then we would need to find out how many moles of CO_2 could be produced by constructing a picket fence-

We would then plug the number of moles into pv=nrt to solve for the volume produced.
REMEMBER to convert the units to the proper units of pv=nrt. Kelvin and Atm

Density and molar mass-

Pv=nrt can be used to solve for a gasses density or its molar mass given the density

D = pm/rt   where D is density and m is molar mass. If you are given the density you can find the molar mass by m=drt/p

This can be used to find the identity of an unknown gas if you know its density. Here is an example-

Calculate the molar mass of the following unknown vapor. The vapor has a mass of .846g, it occupies a volume of 354 ml, a pressure of 753 torr, and a temp of 100* C.

First use the mass and volume to solve for the density

Now use the density to solve for the molar mass

Partial Pressure-

Each gas in a mixture of gasses behaves independently of the other gasses present. Therefore, each gas in the mixture obeys the ideal gas law. Treat each of the gasses separately in the mixture.

Four equations govern the treatment of partial pressure equations-

1. Dalton's law- P_{total} = sum of all pressures
2. Mole fraction (X)-   moles of individual gas / total moles in mixture
3. ideal gas equation- pv=nrt
4. partial pressure- $P_1 = (X)(P_t)$

Any time a mixture is given in the problem you will need to use these equations to solve it. Here is an example-

A mixture of 9g of oxygen, 18g of argon, and 25g of carbon dioxide exert a pressure of 2.54 atm. What is the partial pressure of each gas?

First solve for the number of moles of each gas present by constructing picket fences-

Now find the mole ration of each gas and multiply it by the total pressure of the mixture-

Collection of a gas over water-

When experiments are done over water the vapor pressure of the water must be included in the equation. $P_{total} = P_{gas} + P_{water}$ The vapor pressure must be subtracted out of the total pressure before using the ideal gas equation. The vapor pressure of the water can be found using tables or will be given in the problem. Here is an example-

Hydrogen is produced by reacting zinc and sulfuric acid in a liquid environment. The gas is collected over water in a 255 ml container at 24* C and 718 torr. The vapor pressure at 24*C is 22.38 torr. How many moles of hydrogen gas can be collected and how much zinc was reacted?

First, give the balanced equation

Next, subtract the vapor pressure from the total pressure

Now solve for the moles of hydrogen using the ideal gas law.

Use a picket fence to solve for moles of zinc reacted.

Kinetic Molecular Theory-

This model explains the macroscopic (large scale) behavior of gasses at the atomic and molecular level. It has five main postulates-

1. gasses consist of atoms or molecules in continuous, random motion
2. The volume of the gas particles is negligible relative to the volume of their container.
3. attractive and repulsive forces between gas particles are negligible
4. Collisions between gas particles and between gas particles and their container are perfectly elastic. (there is no loss of energy)
5. The average kinetic energy of particles is proportional to the absolute temperature.

Molecular effusion and diffusion-

Effusion- gas escaping through a hole
Diffusion- the spread of a substance through a medium

Graham's law of effusion- $r_1/r_2 = \sqrt{(M_2/M_1)}$

This is saying that the effusion of one gas is related to the effusion of another gas by the square root of their molar masses. Here is an example-

At a particular pressure and temperature, neon gas effuses at a rate of 16 moles/s. What is the rate of effusion for argon under these conditions?

Derivations from ideal behavior-

A qualitative understanding of van der Waals equation and how an ideal gas varies from a real gas is all that is necessary for this section.