Misc Info

- Exam 1 is Thursday 1/29 and will cover material thru 1/22. This coverage will be detailed on 1/22
- New HW assignment posted-not due for 2 weeks, but the material covered will likely all be on the exam. It is possible that this assignment will be augmented on 1/27
- The first posting of scores will be completed by this Thursday

Gases

- What makes them a subject of interest? How are they different in their behavior from the other phases?
- If we have a gas system, what set of properties are needed to define its state?
- P,V,n,T
- What's missing?-Why
- What are the dimensions
  - P: atm,torr(or mm)(1atm=760torr), Pascal, KPascal(KPa)(see text p 343)
  - V: liter or mL
  - N: moles
  - T: K(this is the biggie)=> K=273+^{o}C

Changes of State

- **Regardless of how it is phrased, nearly all discussion of gas behavior can be viewed as a change of state**
- **P_1,V_1,n_1,T_1 => P_2,V_2,n_2,T_2**
- **This is obviously too complex to study so we reduce such systems to binary pairs by setting two of the variable constant during the experiment. The reduction of multivariable systems to two variable ones is a standard methodology.**
- **The key to success is the choice of what to study. What binary experiment is the easiest to perform with limited apparatus?**
- **P and V (n and T constant)**
- **What should be the independent and dependent variables? What is the result? And how is it expressed?**
- **P-independent, V-dependent**
- **Inversely**
- **$P*V_{n,T}$ =constant**
- **$(P_1*V_1)_{n,T} = (P_2*V_2)_{n,T}$ Boyle's Law**
- **What's the logical second experiment? What's the result**

All the binary linkages

- What would you predict all of the binary relationships to look like.
- A binary change of state problem in a gas system is addressable by either
  - (/)* = ?

    or
  - (*)/ = ?
- If one simply takes a moment to reason how the two variables are related, all binary problems are readily solved. Since you are all **more than able** to do this, discussion and problems in this class are not limited to the named gas laws. You need to be able to handle any binary problem.
- Difficulties in this area, like many others tend to arise not from lack of understanding by due to avoidable errors such as failure to convert temperature to K

Higher gas laws

- Given the combination of being able to predict whether variable pairs are directly or inversely related and our ability to place the variables in correct relative geometric position in an equation, numerous gas laws are possible.
- Several are given prominence
  - $(P_1V_1/T_1)_n = (P_2V_2/T_2)_n$
  - **PV=nRT**
    - **R=ideal gas constant**
      - **0.082Latm/moleK**
      - **62.4Ltorr/moleK**
    - **STP (1.00atm, 273K)**
    - **Molar volume at STP for an ideal gas is 22.4L**
- What gas law would relate P,n and T?

The Explanation-KMT

- The very systematic behavior of gases, regardless of their chemical identity-how is it explained?
- KMT
  - A volume of gas is just empty space. A rationalization for this statement can be seen in the fact that liquids expand by a factor of about 1000 when they vaporize. Thus, the actual volume of the compound is negligible. This explains the linearity of the compressibility (Boyle's Law)
  - Gas components don't interact due to their large intercomponent distances. Since they don't interact, what the gas is doesn't matter(all gases are molecular)
  - All properties are explainable based upon the fact that at a given temp KE=3/2*kT
  - All phenomena can be explained by examining the properties of a single gas molecule
- Corrections to this-the van der Waals Eqn(text p 363) as a note-molecules at 1.00atm and 300K have collision frequencies of about 10^9 collisions per second and are traveling at approx 10^4cm/sec

$$(P + \frac{an^2}{V})(V - nb) = nRT$$

Special Aspects-

- Mol weight by gas density-the Dumas Method
- n=PV/RT
- Clearly, if you measure PV and T for a gas you can calculate the number of moles
- All gases are molecular, so if you also determine the mass of the sample then:
  - gmw=mass/moles=mass*(RT/PV)
- Grahams Law-the heavier you are the slower you're moving at a given T ($KE=3/2kT=1/2mv^2$). Thus, the velocity is inversely related to the sqrt(m). If one is interested in comparing the relative speeds of two gases
  - $sqrt(m_a)*v_a=sqrt(m_b)*v_b$
  - $v_a/v_b=sqrt(m_b/m_a)$
  - Thus, one calculate both relative and absolute rates of effusion and diffusion.

- Law of combining volumes
- Since for any gas, n =constant*V, one can substitute volumes for moles in doing stoichiometry.
- When one considers the difficulty of determining the mass of a gas, the utility of this approach becomes apparent
- Thus, gases will react in the volume ratios given by the stoichiometric coefficients.

Dalton's Law of Partial Pressures

- Consider two one liter containers both at the same temperature and with a pressure of one atm. One contains He, the other contains Ar. They are connected by a tube with a valve which is closed.
- The valve opens-what happens to the gases
- What would you observe with regards to the pressure?
- Why is this consistent with our understanding of gas properties and behavior?
- $P_a + P_b = P_T$
- the mole fraction: $X_a = n_a / n_T$
- $\sum X = 1$
- $P_a = X_a * P_T$

- A system consisting of a mixture of j gases can be viewed as having 3j+2 variables
  - j values of n(moles of each gas)
  - j values of P (the partial pressure of each gas)
  - j values of X (mole fraction of each gas)
  - n_T and P_T
  - note: ns are often not considered, so there are only 2j+1 variables
- What subset of the above is sufficient such that all the values can be determined?
  - example: If there are two gases(A and B), knowing P_T and X_A and n_B is sufficient for the determination of all of the values.