Chem 116 Lecture 3 notes
9-9-08 (JL)

- There is no limit on how fast a molecular particle can moves, but there is a limit on how slow. That's why the distribution of speeds is not symmetric, and why it gets spread out further at higher temperature, but there can always be particles moving slowly too.
- root mean square velocity (rms)

$$v_{\text{rms}} = \sqrt{\frac{\sum_{i=1}^{i=N} v_i^2}{N}} = \sqrt{\frac{v_1^2 + v_2^2 + +\ldots\ v_N^2}{N}}$$

- As temperature doubles, Kinetic Energy (KE) also doubles.
  - $KE = \frac{1}{2}Mv^2 = \frac{1}{2}M\frac{3RT}{M} = \frac{3}{2}RT$ … temperature(T) is only variable that KE depends on.

- Heavier gas particles move slower on average; Lighter gas particles move faster on average.
  - $v_{rms} = (3RT/M)^{1/2}$ …mass(M) is inversely proportional to v_{rms}. Also T is directly proportional to v_{rms}.
- Velocity of a moving molecular particle tells you its molecular weight.
  - Velocity can characterize unknown gas particle.
- Larger mass = slower rate of effusion.
- Equation of Graham's law of effusion: $\frac{v_A}{v_B} = \sqrt{\frac{M_B}{M_A}}$ …velocity is inversely proportional to M
- Balloon question.
  - SF_6 balloon got bigger after two days under same temperature and pressure.
    - SF effuses slower than N_2, which mostly made up the air.
    - Calculate Rate of Effusion. (assume that air is 100% $N_{2)}$

$$\frac{v_{N_2}}{v_{SF_6}} = \sqrt{\frac{M_{SF_6}}{M_{N_2}}} = \sqrt{\frac{146}{28}} = 2.28$$

    N_2 Effuse in 2.28 faster than SF_6
- Graham's law Example: A sample of pure methane, CH_4, is found to effuse through a porous barrier in 1.50 min. Under the same conditions, an equal number of molecules of an unknown gas effuses through the barrier in 4.73 min. What is the molar mass of the unknown gas?
  - $(V_{CH4}/V_{unk}) = (M_{unk}/M_{CH4}) = (T_{unk}/T_{CH4})^2$

$M_{unk} = M_{CH4}\,(T_{unk}/T_{CH4})^2$

$= (16.0\text{ g/mol})\,(4.73\text{min.}/1.50\text{min.})^2$

$=159\text{g/mol}$ …check significant number.