59-240
Lecture 3
Kinetic Model of Gases

Properties of gases
- Low density
- High compressibility
- External pressure contains a gas
- Gases diffuse into one another - they mix homogeneously

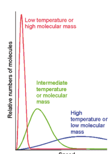
Kinetic model assumptions
- Atoms/molecules undergo random never-ending motion
- Molecular size is negligible compared to distances traveled by molecules
- Molecules are hard spheres which make elastic collisions

Derivation of: $pV = \frac{1}{3}nMc^2 \quad , \quad c = \langle v^2 \rangle^{1/2}$
- Distance
- Volume
- Density
- Stats (0.5)
- Momentum
- Force
- Average

RMS Speed $c = \left(\frac{3RT}{M}\right)^{1/2}$

Relative Speeds
- $\bar{c}_{rel} = 2^{1/2}\bar{c} = \left(\frac{8kT}{\pi\mu}\right)^{1/2}, \quad \mu = \frac{m_A m_B}{m_A + m_B}$ Relative Mean Speed
- $z = \frac{\sigma\bar{c}_{rel}N}{V} = \frac{\sigma\bar{c}_{rel}p}{kT}, \quad \sigma = \pi d^2$ Collision Frequency
- $\lambda = \frac{\bar{c}}{z} = \frac{kT}{2^{1/2}\sigma p}$ Mean Free Path

Speeds
- $c = \left(\frac{3RT}{M}\right)^{1/2}$ RMS
- $\bar{c} = \left(\frac{8RT}{\pi M}\right)^{1/2}$ Mean
- $c^* = \left(\frac{2RT}{M}\right)^{1/2}$ Most probable

Maxwell Distribution
- $f(v) = 4\pi\left(\frac{M}{2\pi RT}\right)^{3/2} v^2 e^{-Mv^2/2RT}$
- 

Plots of population vs. speeds
- Fraction between v_1 and $v_2 = \int_{v_1}^{v_2} f(v)\, dv$
- Derivation (review this)