Quantifying Kinetic Molecular Theory

$N_A = 6.02\text{E}23 \ \frac{1}{mol}$

N = # molecules in a sample

n = # moles in a sample

$$n = \frac{N}{N_A}$$

or

$$n = \frac{M_{sample}}{M} = \frac{M_{sample}}{m N_A}$$

M = molar mass

m = molecular mass

Ideal Gas Law

$$pV = nRT$$

$R = 8.31 \ \frac{J}{mol\,K}$

p = absolute pressure (Pa)

V = volume (m^3)

n = # moles

T = temperature (K)

Alternate form

$$pV = NkT$$

$$k = \frac{R}{N_A} = 1.38\,E{-}23 \ \frac{J}{K}$$

$$V_{rms} = \sqrt{\frac{3RT}{M}}$$

* see text for complete derivation

The key idea is that the rms speed is an average speed of sorts that can be used to describe the speed of the molecules of a gas.

$$E_{K_{Average}} = \frac{3}{2} kT$$

Translational kinetic energy of a molecule based on v_{rms}.

Mean Free Path (λ)

- Path traveled without interaction

$$\lambda = \frac{1}{\sqrt{2}\, \pi d^2 \left(\frac{N}{V}\right)}$$

d = molecular diameter

$\frac{N}{V}$ = # molecules per unit volume

* See text for derivation