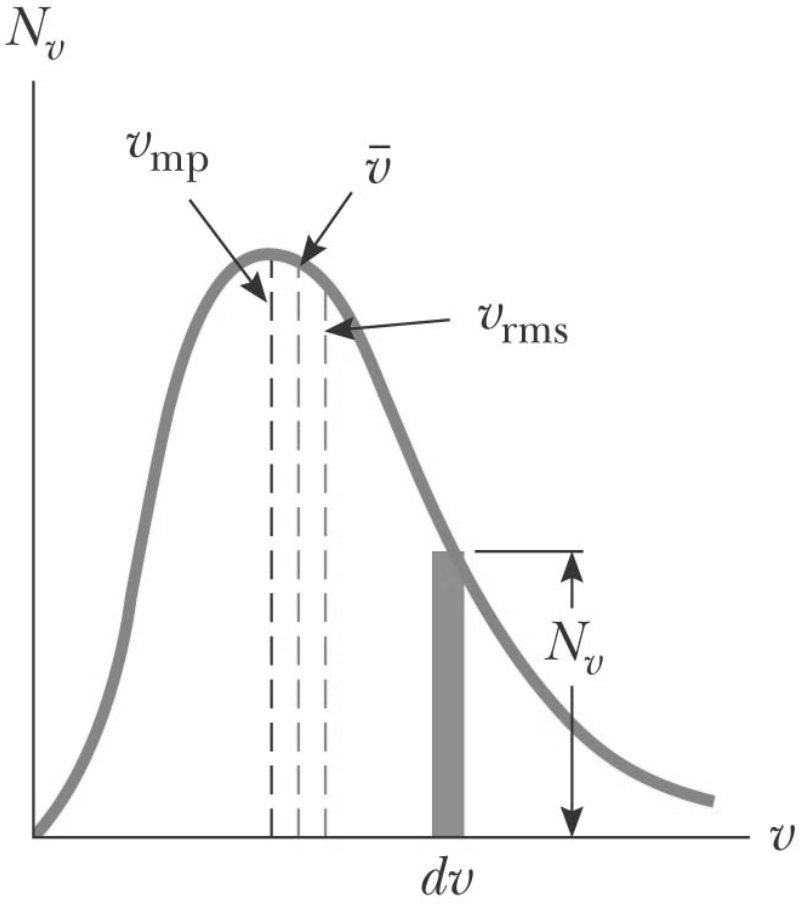
Distribution of Molecular Speeds

- The observed speed distribution of gas molecules in thermal equilibrium is shown at right
- N_V is called the **Maxwell-Boltzmann speed distribution function**



Distribution Function

- The fundamental expression that describes the distribution of speeds in *N* gas molecules is

$$N_V = 4\pi N \left(\frac{m}{2\pi k_{\mathrm{B}} T} \right)^{3/2} v^2 e^{-mv^2/2k_B T}$$

- *m* is the mass of a gas molecule, k_B is Boltzmann's constant and *T* is the absolute temperature

Most Probable Speed

- The average speed is somewhat lower than the rms speed
- The most probable speed, v_{mp} is the speed at which the distribution curve reaches a peak

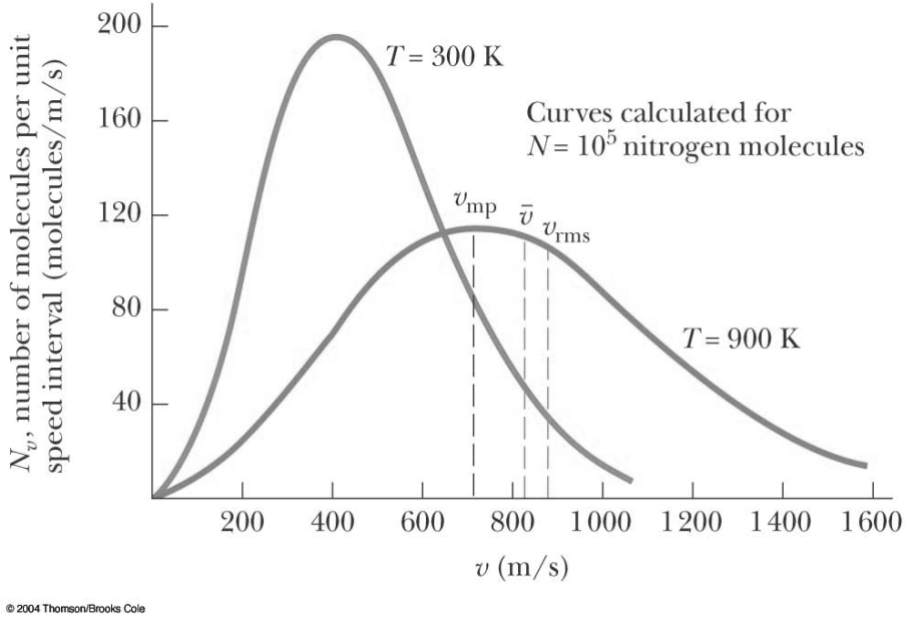
$$v_{mp} = \sqrt{\frac{2k_B T}{m}} = 1.41\sqrt{\frac{k_B T}{m}}$$

Speed Distribution

The peak shifts to the right as *T* increases

- This shows that the average speed increases with increasing temperature

The asymmetric shape occurs because the lowest possible speed is 0 and the highest is infinity



Speed Distribution

- The distribution of molecular speeds depends both on the mass and on temperature

- **The speed distribution for liquids is similar to that of gases**

Evaporation

- Some molecules in the liquid are more energetic than others
- Some of the faster moving molecules penetrate the surface and leave the liquid
  - This occurs even before the boiling point is reached
- The molecules that escape are those that have enough energy to overcome the attractive forces of the molecules in the liquid phase
- The molecules left behind have lower kinetic energies
- Therefore, evaporation is a cooling process

Additional reading:

B. H. Flowers and E. Mendoza, Properties of Matter

M. de Podesta, Understanding the Properties of Matter

Play with these sites:

http://intro.chem.okstate.edu/1314F00/Laboratory/GLP.htm

http://phet-web.colorado.edu/new/simulations/sims.php?sim=Gas_Properties