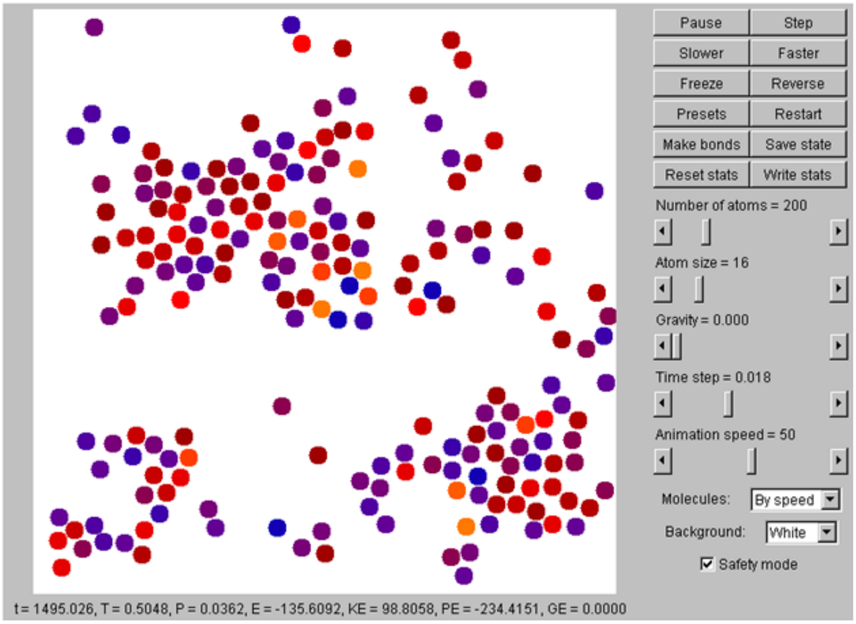
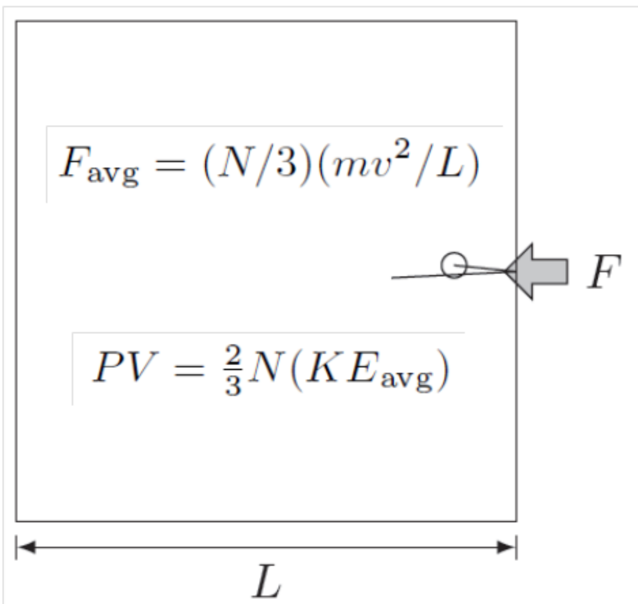
Kinetic Theory

The kinetic hypothesis identifies heat energy with the random mechanical energy of molecules



http://physics.weber.edu/schroeder/software/MDApplet.html

The simplest thermal system is one with no molecular interaction at all — an ideal gas



$$E = \frac{1}{2}kT$$

$$U = \frac{3}{2}NkT$$

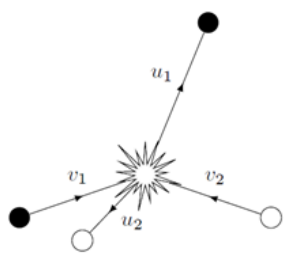
$$PV = NkT$$

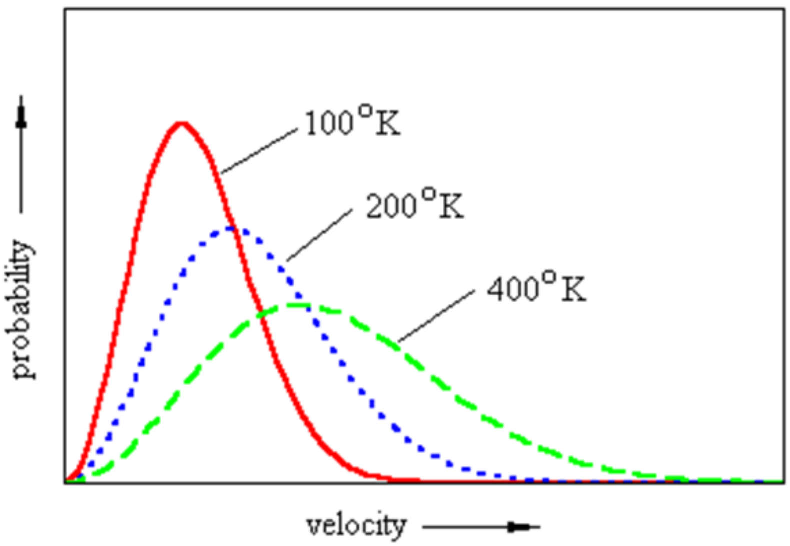
$$k = R/N_A$$

The Maxwell-Boltzman distribution depicts the molecular speeds in an ideal gas

$$v_{\text{avg}} = \sqrt{3kT/M}$$

$$N \propto v^2 \exp(-\tfrac{1}{2}mv^2/kT)$$





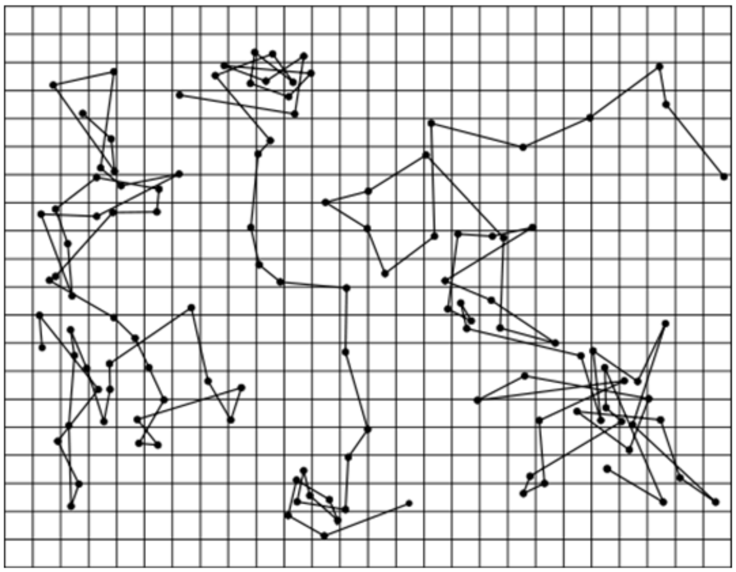
Entropy measures the distribution of internal energy in a system

E_1	E_2	Ω_1	Ω_2	Ω
0	5	0	25	0
1	4	1	16	16
2	3	8	9	72
3	2	27	4	108
4	1	64	1	64
5	0	125	0	0

$$\Omega \propto E^{d/2}$$

$$S = k \ln \Omega$$

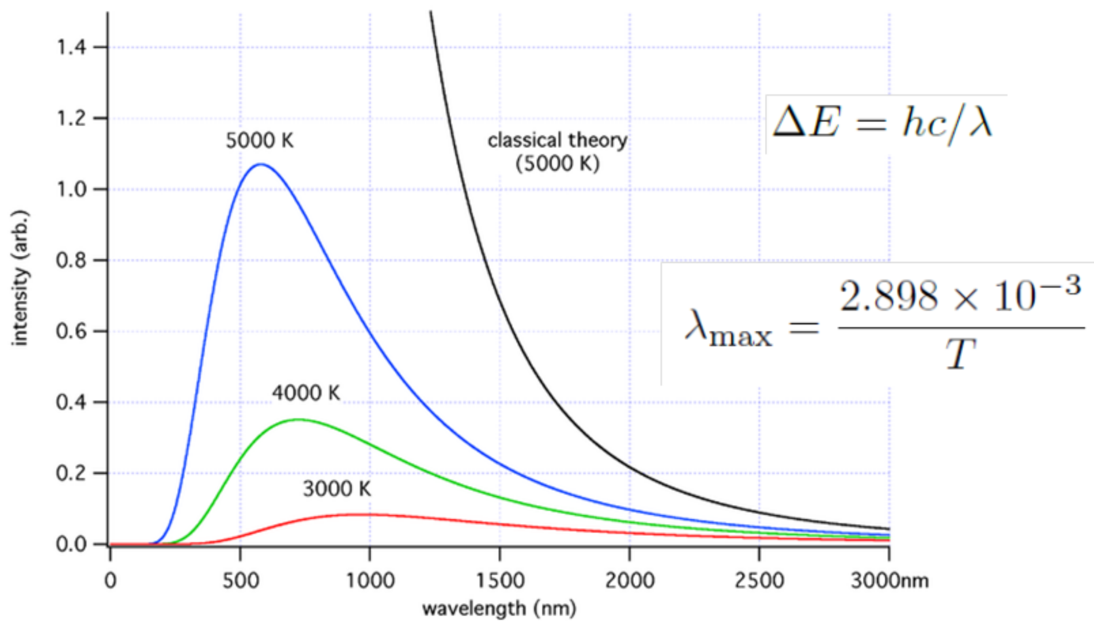
Fick's law of diffusion and Brownian motion also follows from the kinetic hypothesis



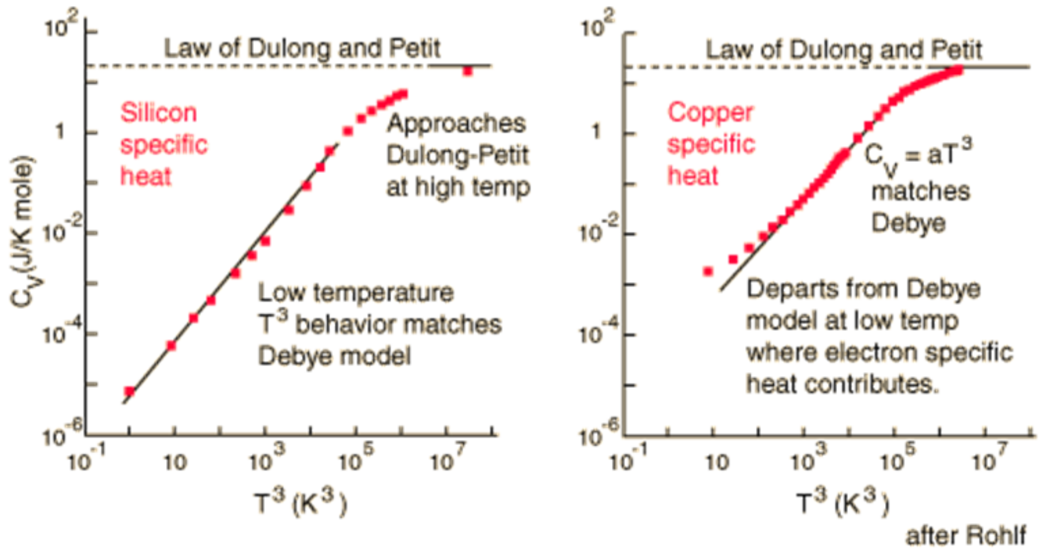
$$\frac{M}{t} = DA\frac{\Delta C}{\Delta x}$$

$$D = kT/6\pi\eta r$$

Statistical mechanics based on Newton's laws is not as successful as it should be



The root cause of this failure appears to be "frozen" degrees of freedom



$$\cancel{C/n = 3R \sim 25}$$

These considerations paved the way to a new theory of quantum mechanics