Chapter 11
Maxwell Distribution

Here we consider a volume of an ideal gas comprising molecules in random motion.

If $D(c_i)\mathrm{d}c_i$ is the fraction of molecules within the fractional velocity range c_i to $c_i + \mathrm{d}c_i$ then the product

$$D(c_1)D(c_2)D(c_3) \tag{11.1}$$

is the fraction (n) of molecules with velocity $c = \sqrt{c_1^2 + c_2^2 + c_3^2}$.

Thus

$$n(c) = D(c_1)D(c_2)D(c_3) \tag{11.2}$$

This equation can, by expressing it in logarithmic form and differentiating both sides, be recast in the form:

$$\frac{1}{c}\frac{\mathrm{d}(\ln \mathrm{n})}{\mathrm{d}c} = \frac{1}{c_i}\frac{\mathrm{d}(\ln \mathrm{D})}{\mathrm{d}c_i} = \text{constant}$$

The 'constant' is necessary if the equation is to be true for all values of c_i.

The solution to this equation is:

$$D(c_i) = \frac{1}{\sqrt{2\pi\frac{k}{\mu}T}}\exp\left[-\frac{\mu c_i^2}{2kT}\right] \tag{11.3}$$

where k is the Boltzmann constant and μ is the molecular weight for the gas. Hence given that the kinetic energy of a molecule is:

$$E = \frac{\mu c_i^2}{2}\ \mathrm{J} \tag{11.4}$$

we can write:

$$D(c_i) = \frac{1}{\sqrt{2\pi\frac{k}{\mu}T}}\exp\left[-\frac{E}{kT}\right] \tag{11.5}$$

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