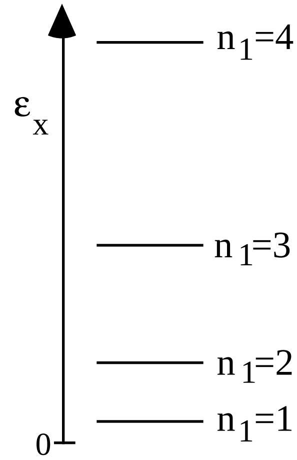
Translational Partition Function

$$\varepsilon_t = \frac{h^2}{8m}\left(\frac{n_1^2}{a^2} + \frac{n_2^2}{b^2} + \frac{n_3^2}{c^2}\right)$$

$$q_t = q_x\, q_y\, q_z$$



$$q_x = \sum_i e^{-ß\varepsilon_i} = \sum_i e^{-ßh^2 n_1^2/8ma^2}$$

$$q_x = \int_0^\infty e^{-ßh^2 n_1^2/8ma^2}\, dn_1$$

$$x^2 = ß\,\frac{h^2 n_1^2}{8ma^2}$$

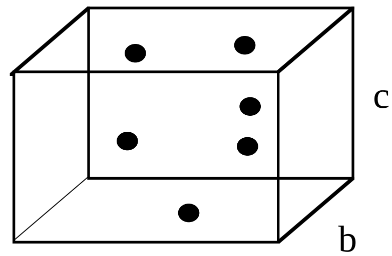
$$q_x = \frac{a}{h}\left(\frac{8m}{ß}\right)^{1/2} \int_0^\infty e^{-x^2}\, dx$$

$$\int_0^\infty e^{-x^2}\, dx = \frac{\sqrt{\pi}}{2}$$

$$q_x = \frac{a}{h}\left(\frac{2\pi m}{ß}\right)^{1/2}$$

$$q_t = \left(\frac{2\pi m}{ß}\right)^{3/2} \frac{V}{h^3} \qquad V = a\, b\, c$$

ß and the Translational Partition Function



experimental: $U - U(0) = \frac{3}{2} n RT$

$$U - U(0) = -\frac{1}{Q}\left(\frac{\partial Q}{\partial ß}\right)_V \qquad Q = \frac{q^N}{N!}$$

$$\left(\frac{\partial Q}{\partial ß}\right)_V = \frac{1}{N!}\left(\frac{\partial q^N}{\partial ß}\right) = \frac{N\, q^{N-1}}{N!}\left(\frac{\partial q}{\partial ß}\right)$$

$$U - U(0) = \frac{-N}{q}\left(\frac{\partial q}{\partial ß}\right)_V$$

$$\left(\frac{\partial q}{\partial ß}\right)_V = \left((2\pi m)^{3/2}\frac{V}{h^3}\right)\left(\frac{-3}{2}ß^{-5/2}\right)$$

$$U - U(0) = \frac{-N\left((2\pi m)^{3/2}\frac{V}{h^3}\right)\left(\frac{-3}{2}ß^{-5/2}\right)}{\left((2\pi m)^{3/2}\frac{V}{h^3}\right)\left(ß^{-3/2}\right)}$$

$$U - U(0) = \frac{3}{2}\frac{N}{ß}$$

$$U - U(0) = \frac{3}{2}\frac{N}{ß} = \frac{3}{2} n RT = \frac{3}{2}\frac{N}{N_A} RT = \frac{3}{2} N kT$$

$\frac{1}{ß} = kT$ or $ß = \frac{1}{kT}$