$$Q_N(T,V) = V^N \left[\frac{1}{h^3} \int_0^\infty e^{-\frac{p^2}{2mk_BT}} 4\pi p^2 dp \right]^N$$

$$\left[Q_1(T,V)\right]^N$$

$$Q_N(T,V) = \left[\frac{V}{h^3} (2\pi m k_B T)^{3/2} \right]^N$$

$$\left(\frac{h}{2\pi m k_B T}\right)^{1/2} \equiv \lambda_T$$

$$= \left[\frac{V}{\lambda_T^3}\right]^N \quad \left(\equiv \left[\left(\frac{L}{\lambda_T}\right)^3\right]^N\right.$$

$$\boxed{Q_N(T,V) = \frac{1}{N!} \left[\frac{V}{\lambda_T^3}\right]^N} \qquad Q_1 = \frac{V}{\lambda_T^3}$$

[illegible]

$$F = -(k_BT) \ln Q_N(T,V)$$

$$\begin{array}{c} ||| \\ \left[Q_1(T,V)\right]^N \end{array}$$

$$F = -(k_BT) N \ln Q_1(T,V)$$

$$F = -(k_BT) N \ln\left(\frac{V}{\lambda_T^3}\right)$$

$$\mu \equiv \left(\frac{\partial F}{\partial N}\right)_{V,T}$$