$$\int_0^\infty e^{-ax^2}dx = \frac{1}{2}\sqrt{\frac{\pi}{a}},\ \int_0^\infty xe^{-ax^2}dx = \frac{1}{2a},\ \int_0^\infty x^2e^{-ax^2}dx = \frac{1}{4}\sqrt{\frac{\pi}{a^3}}$$

$$\int_0^\infty x^3e^{-ax^2}dx = \frac{1}{2a^2},\ \int_0^\infty x^4e^{-ax^2}dx = \frac{3}{8}\sqrt{\frac{\pi}{a^5}},\ \int_0^\infty x^6e^{-ax^2}dx = \frac{15}{16}\sqrt{\frac{\pi}{a^7}}$$

$$\sigma_x = \left(\langle x^2\rangle - \langle x\rangle^2\right)^{1/2},\ \mathbf{c} = (A^TA)^{-1}A^T\mathbf{b},\ a = \frac{\bar{xy} - \bar{x}\cdot\bar{y}}{\bar{x^2} - \bar{x}^2},\ b = \frac{\bar{x^2}\cdot\bar{y} - \bar{x}\cdot\bar{xy}}{\bar{x^2} - \bar{x}^2}$$

$$PV_m = RT,\ P = \frac{RT}{V_m - b} - \frac{a}{V_m^2},\ Z = \frac{PV_m}{RT} = 1 + \frac{B(T)}{V_m} + \frac{C(T)}{V_m^2} + \cdots,\ w = -P\Delta V$$

$$\Delta U = q + w = C_V\Delta T,\ H = U + PV,\ \Delta H = q_P = C_P\Delta T,\ C_P - C_V = nR,\ C_P = \left(\frac{\partial H}{\partial T}\right)_P$$

$$\Delta H(T_2) = \Delta H(T_1) + \int_{T_1}^{T_2}\Delta C_P dT,\ \Delta S(T_2) = \Delta S(T_1) + \int_{T_1}^{T_2}\frac{\Delta C_P}{T}dT,\ \Delta S = \int_i^f \frac{q_{\text{rev}}}{T}\,dT$$

$$A = U - TS,\ G = H - TS = A + PV,\ dU = TdS - PdV,\ dA = -SdT - PdV$$

$$dH = TdS + VdP,\ dG = -SdT + VdP + \sum_i \mu_i dn_i = -SdT + vdP + \left(\sum_i \nu_i\mu_i\right)d\xi$$

$$dG' = -S'dT + PdV + \sum_{i\neq \text{H}} \mu' dn' + n_C(\text{H})\,RT\,\ln 10\,p\text{H},\ \Delta_f G_i'^{\circ} = -RT\ln\sum_j e^{-\Delta_f G_j'^{\circ}/RT}$$

$$W(n_0, n_1, n_2, ...) = \frac{N!}{n_0!n_1!n_2!...},\ \ln x! \sim x\ln x - x,\ \frac{n_i}{N} = \frac{e^{-\beta\epsilon_i}}{\sum_j e^{-\beta\epsilon_j}},\ \beta = 1/k_BT$$

$$q = \sum_i e^{-\beta\epsilon_i} = \sum_j g_j\ e^{-\beta\epsilon_j}, \langle\epsilon\rangle = -\frac{1}{q}\frac{dq}{d\beta},\ q = q^Tq^Rq^Vq^E,\ C_V = \left(\frac{\partial\langle\epsilon\rangle}{\partial T}\right)_V$$

$$q^R = \sum_{J=0}^{\infty}(2J+1)\ e^{-\beta hcBJ(J+1)},\ B = \frac{\hbar}{4\pi cI},\ q^R = \frac{T}{\Theta_R},\ q^R = \frac{1}{\sigma}\left(\frac{k_BT}{hc}\right)^{3/2}\left(\frac{\pi}{ABC}\right)^{1/2}$$

$$q^V = \frac{1}{(1 - e^{-h\nu\beta})} = \frac{k_BT}{h\nu},\ \Theta_V = \frac{h\nu}{k_B},\ \Theta_R = \frac{\sigma hcB}{k_B},\ q^T = \frac{V}{\Lambda^3},\ \Lambda = \frac{h}{\sqrt{2\pi mk_BT}}$$

$$Q = q^N,\ Q = q^N/N!,\ \ U(T,V) = U(0,V) - \left(\frac{\partial\ln Q}{\partial\beta}\right)_V,\ S = k_B\ln\Omega$$

$$S = \frac{U - U(0)}{T} + k_B\ln Q = Nk_B\ln\left(\frac{e^{5/2}V}{N\Lambda^3}\right),\ S_m^{\Theta} = \frac{U_m - U_m(0)}{T} + R\left(\ln\frac{q_m^{\Theta}}{N_A} + 1\right)$$

$$\sum_i \nu_iB_i = 0,\ K = \prod_i a_{eq,i}^{\nu_i},\ K_P = \prod_i\left(\frac{P_i}{P^\circ}\right)^{\nu_i},\ K_C = K_P\left(\frac{P^\circ}{c^\circ RT}\right)^{\nu},\ Q = \prod_i a_i^{\nu_i}$$

$$K_x = K_P\left(\frac{P}{P^\circ}\right)^{-\nu},\ K_P = \left(\frac{P/P^\circ}{n_0 + \nu\xi + n_{\text{inert}}}\right)^{\nu}\prod_i(n_{i0} + \nu_i\xi)^{\nu_i}$$

$$\Delta_rG^\circ = \left(\frac{\partial G}{\partial\xi}\right)_{T,P} = -RT\ln K,\ \Delta_rG = \Delta_rG^\circ + RT\ln Q,\ \mu_i = \mu_i^\circ + RT\ln a_i$$

$$\Delta_rH^\circ = RT^2\left(\frac{\partial\ln K_P}{\partial T}\right),\ \ln\frac{K_2}{K_1} = \frac{-\Delta_rH^\circ}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right),\ \ln K = -\frac{\Delta_rH^\circ}{RT} + \frac{\Delta_rS^\circ}{R}$$

$$E^\circ = \frac{RT}{|\nu_e|F}\ln K,\ E = E^\circ - \frac{RT}{|\nu_e|F}\ln Q,\ \Delta_r G^\circ = -|\nu_e|FE^\circ,\ E = E_R - E_L$$

$$\mu_i = \mu_i^\circ + RT\ln a_i,\ a_i = \gamma_i \frac{m_i}{m^\circ},\ \gamma_\pm = (\gamma_+^{\nu_+}\gamma_-^{\nu_-})^{1/\nu_\pm},\ I = \frac{1}{2}\sum_i z_i^2(\frac{m_i}{m^\circ}) = \frac{m}{2m^\circ}\sum_i \nu_i z_i^2$$

$$\Delta_f G_i^\circ(I) = \Delta_f G_i^\circ(I=0) + RT\ln\gamma_i,\ \Delta_f H_i^\circ(I) = \Delta_f H_i^\circ(I=0) + RT^2\left(\frac{\partial \ln\gamma_i}{\partial T}\right)_P$$

$$\log\gamma_\pm = Az_+z_-\sqrt{I},\ \log\gamma_\pm = \frac{Az_+z_-\sqrt{I}}{1+B\sqrt{I}},\ \log\gamma_\pm = Az_+z_-\left(\frac{\sqrt{I}}{1+\sqrt{I}} - CI\right)$$

$$A = \frac{1}{\ln 10}\left(\frac{2\pi N_A m_s}{Vm^\circ}\right)^{1/2}\left(\frac{e^2}{4\pi\varepsilon k_B T}\right)^{3/2} = 0.509,\ \frac{dA}{dT} = -0.00256,\ B = 1.6,\ C = 0.30$$

$$\Delta V = IR,\ R = \frac{L}{\kappa A},\ \kappa = F\sum_i |z_i|c_i u_i = \sum_i \lambda_i c_i,\ u = \frac{v_E}{E},\ \Lambda_m = \frac{\kappa}{c}$$

$$f(v_x) = \left(\frac{m}{2\pi k_B T}\right)^{1/2} e^{-mv_x^2/2k_BT},\ F(v) = 4\pi\left(\frac{m}{2\pi k_B T}\right)^{3/2} v^2 e^{-mv^2/2k_BT}$$

$$\langle v\rangle = \left(\frac{8k_BT}{\pi m}\right)^{1/2},\ \langle v^2\rangle^{1/2} = \left(\frac{3k_BT}{m}\right)^{1/2},\ v_{\rm mp} = \left(\frac{2k_BT}{m}\right)^{1/2},\ \langle v_{12}\rangle = \left(\frac{8k_BT}{\pi\mu}\right)^{1/2}$$

$$z_{12} = \rho_2\pi d_{12}^2\langle v_{12}\rangle,\ Z_{12} = \rho_1\rho_2\pi d_{12}^2\langle v_{12}\rangle,\ z = 2^{1/2}\rho\pi d^2\langle v\rangle,\ Z = 2^{-1/2}\rho^2\pi d^2\langle v\rangle$$

$$\lambda = \frac{1}{\sqrt{2}\rho\pi d^2},\ J_N = \frac{\rho\langle v\rangle}{4} = \frac{\Delta w}{mtA},\ \chi(b) = 2\arccos\frac{b}{d},\ \eta = \frac{5\pi}{32}\rho m\lambda\langle v\rangle,\ \mathbf{F} = -\eta\nabla u$$

$$D = \frac{3\pi}{4}\lambda\langle v\rangle,\ \mathbf{J} = -D\nabla\rho,\ \frac{\partial\rho}{\partial t} = D\nabla^2\rho,\ \frac{\partial c}{\partial t} = D\nabla^2 c,\ D = \frac{k_BT}{f},\ D = \frac{k_BT}{6\pi\eta r}$$

$$c(x,t) = \frac{n_0}{A\sqrt{\pi Dt}}e^{\frac{-x^2}{4Dt}},\ \langle x^2\rangle = 2Dt,\ \langle x\rangle = 2\left(\frac{Dt}{\pi}\right)^{1/2},\ P(x,t) = \left(\frac{2\tau}{\pi t}\right)^{1/2} e^{\frac{-x^2\tau}{2t\lambda^2}},\ D = \frac{\lambda^2}{2\tau}$$

$$[A] = [A]_0 e^{-kt},\ t_{1/2} = \frac{\ln 2}{k},\ \frac{1}{[A]} - \frac{1}{[A]_0} = kt,\ t_{1/2} = \frac{1}{k[A]_0},\ [A]_0 - [A] = kt,\ t_{1/2} = \frac{[A]_0}{2k}$$

$$[A] = \frac{k_{-1}[A]_0}{k_1+k_{-1}}\left(1 + \frac{k_1}{k_{-1}}e^{-(k_1+k_{-1})t}\right),\ k = Ae^{-E_a/RT},\ E_a = RT^2\frac{d\ln k}{dT},\ \frac{k_f}{k_b} = K_c(c^\circ)^\nu$$

$$v = \frac{v_{max}[S]_0}{[S]_0 + K_M},\ K_M = \frac{k_{-1}+k_2}{k_1},\ v_{max} = k_2[E]_0,\ k_{cat} = \frac{v_{max}}{N_c[E]_0}$$

$$v = \frac{v_{max}[S]_0}{[S]_0 + K_M\left(1 + \frac{[I]}{K_I}\right)}$$

$$V(r) \ = \ D\ \left(e^{-2\alpha(r-r_b)} - 2e^{-\alpha(r-r_b)}\right)$$

$$P(\vec{x},\vec{v})\ d\vec{x}d\vec{v}\ = A\ e^{-E(\vec{x},\vec{v})/k_BT}\ d\vec{x}d\vec{v},\ Z_S \ = \ \int_S e^{-V(\vec{x})/k_BT}\ d\vec{x}$$

$$k^{TST} \ = \ \sqrt{\frac{k_BT}{2\pi\mu}}\ \frac{Z^\ddagger}{Z^R},\ k^{HTST} \ = \ \frac{\Pi_i^D \nu_{R,i}}{\Pi_i^{D-1}\nu_{\ddagger,i}}\ e^{-(V_{SP}-V_{min})/k_BT}$$