__**Useful Equations and Constants:**__

$$F = mg \qquad P = \frac{F}{A} \qquad P = \rho g h$$

$$\frac{dP}{dT} = \frac{\Delta H_m}{T \Delta V_m} \qquad \frac{dP}{dT} = \frac{\Delta_{\text{vap}} H_m P}{RT^2} \qquad \ln\frac{P_2}{P_1} = \frac{\Delta_{\text{vap}} H_m}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

$$\frac{dP}{dP_t} = \frac{V_m(\text{l})}{V_m(\text{v})} \qquad \ln\frac{P}{P_{\text{v}}} = \frac{V_m(\text{l})}{RT}\left(P_t - P_{\text{v}}\right) \qquad P_1 = x_1 P_1^*$$

$$P_2 = k' x_2 \qquad \mu_i = \mu_i^* + RT \ln\frac{P_i}{P_i^*} \qquad \mu_i = \mu_i^* + RT \ln a_i$$

$$\mu_i = \mu_i^* + RT \ln x_i \qquad \mu_i = \mu_{i,\text{ideal}} + RT \ln f_i \qquad \mu_i = \mu_{i,\text{ideal}} + RT \ln \gamma_i$$

$$\Delta_{\text{mix}} G = n_{\text{total}} RT \sum_i x_i \ln x_i \qquad \Delta_{\text{mix}} S = -n_{\text{total}} R \sum_i x_i \ln x_i \qquad \ln x_1 = \frac{\Delta_{\text{fus}} H_m}{R}\left(\frac{1}{T_f^*} - \frac{1}{T}\right)$$

$$\Delta_{\text{fus}} T \approx \frac{M_1 R T_f^{*2}}{\Delta_{\text{fus}} H_m} \cdot m_2 \qquad \Delta_{\text{fus}} T = K_f m_2 \qquad \ln x_1 = \frac{\Delta_{\text{vap}} H_m}{R}\left(\frac{1}{T} - \frac{1}{T_b^*}\right)$$

$$\Delta_{\text{vap}} T \approx \frac{M_1 R T_b^{*2}}{\Delta_{\text{vap}} H_m} \cdot m_2 \qquad \Delta_{\text{vap}} T = K_b m_2 \qquad \pi = \frac{n_2 RT}{n_1 V_1^*}$$

$$\pi = \frac{n_2 RT}{V} \qquad \pi \approx cRT \qquad F = C - P + 2$$

$$\Delta_{\text{fus}} S = \frac{\Delta_{\text{fus}} H}{T_f} \qquad \Delta_{\text{vap}} S = \frac{\Delta_{\text{vap}} H}{T_{bp}} \qquad \frac{n_A}{n_B} = \frac{P_A^*}{P_B^*}$$

$$\vec{F} = \vec{F}(\vec{r}) = -\frac{Q_1 Q_2}{4\pi\varepsilon_0 \varepsilon r_{12}^2}\overrightarrow{r_{12}} \qquad \vec{F} = q\vec{E} \qquad \vec{E} = -\vec{\nabla}\emptyset \qquad \vec{F} = -\vec{\nabla} V$$

$$\emptyset = \frac{q}{4\pi\varepsilon_0 \varepsilon r} \qquad V = \frac{q_1 q_2}{4\pi\varepsilon_0 \varepsilon r} \qquad G = \kappa\frac{A}{l} \qquad \Lambda = \frac{\kappa}{c} \qquad \frac{1}{K} = \left(\frac{\varepsilon\varepsilon_0 k_B T}{e^2 \sum_i c_i z_i^2 \, L}\right)^{\frac{1}{2}}$$

$$\Lambda = \Lambda^\circ - (P + Q^\circ \Lambda^\circ)\sqrt{c} \qquad K = \frac{c\left(\frac{\Lambda}{\Lambda^0}\right)^2}{1 - \left(\frac{\Lambda}{\Lambda^0}\right)} \qquad K = \frac{c\alpha^2}{1 - \alpha}$$

$$\Lambda^{\text{o}} = \lambda_+^{\text{o}} + \lambda_-^{\text{o}} \quad \lambda_+^{\text{o}} = F u_+ \qquad t^+ = \frac{u^+}{u^+ + u^-} \qquad t^- = \frac{u^-}{u^+ + u^-}$$

$D = \frac{kT}{Q} u$ $\Lambda\eta = \text{const}$ $I = \frac{1}{2}\sum_i c_i z_i^2$

$\Delta_{hyd} G^0 = \frac{Z^2 e^2}{8\pi\varepsilon_0 r}\left(\frac{1}{\varepsilon} - 1\right)$ $\Delta_{hyd} S^o = \frac{z^2 e^2}{8\pi\varepsilon_0 \varepsilon r}\left(\frac{\partial \ln\varepsilon}{\partial T}\right)$

$\log_{10}\gamma_\pm = -0.512|z_+||z_-|\sqrt{I}$ $G_i = G_i^o + kT\ln c_i\gamma_i$ $pH = -\log[H^+]$

$\Delta G^o = -zFE^o$ $\Delta G^o = -zFE^o$ $E^o = \frac{RT}{zF}\ln K^o$

$E = E^o - \frac{RT}{zF}\ln Q$ $E = E^0 - \frac{RT}{zF}\ln\left(\frac{[Y]^y[Z]^z}{[A]^a[B]^b}\right)^u$ $\Delta\Phi = \frac{RT}{ZF}\ln\frac{c_1}{c_2}$

$c = \nu\lambda$ $E = h\nu$ $\lambda = \frac{h}{p}$

$\text{K.E.} = h\nu - h\nu_0$ $\tilde{\nu} = Z^2\tilde{R}_H\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$ $\tilde{\nu} = \frac{1}{\lambda}$

$\tilde{R}_H = \frac{e^2}{8\pi\varepsilon_0 a_0 hc}$ $\Delta q\Delta p \geq \frac{\hbar}{2}$ $\Delta E\Delta t \geq \frac{\hbar}{2}$

$\Delta\phi\Delta L \geq \frac{\hbar}{2}$ $\hat{H}\psi(x,y,z) = E\psi(x,y,z)$

$\hat{H}\Psi(x,y,z,t) = i\hbar\frac{\partial\Psi(x,y,z,t)}{\partial t}$

$\langle A\rangle = \frac{\int\psi^*\hat{A}\psi d\tau}{\int\psi^*\psi d\tau}$ $\psi_n = \sqrt{\frac{2}{a}}\sin\left(\frac{n\pi x}{a}\right)$ $E_n = \frac{n^2h^2}{8ma^2}$

$E_{n_x,n_y} = \frac{h^2}{8m}\left(\frac{n_x^2}{a^2} + \frac{n_y^2}{b^2}\right)$ $E_{n_x,n_y,n_z} = \frac{h^2}{8m}\left(\frac{n_x^2}{a^2} + \frac{n_y^2}{b^2} + \frac{n_z^2}{c^2}\right)$ $E_n = -\frac{Z^2e^2}{8\pi\varepsilon_0 n^2 a_0}$

$L^2 = l(l+1)\hbar^2$ $L_z = m_l\hbar$ $m_l = -l, -l+1, \ldots l-1, l$ $\nu_0 = \frac{1}{2\pi}\sqrt{\frac{k}{\mu}}$

$\mu = \frac{m_1m_2}{m_1+m_2}$ $E_n = h\nu_0\left(n + \frac{1}{2}\right)$ $I = \mu r^2$

$B = \frac{h}{8\pi^2 I}$ $\nu = 2(J+1)B$ $\frac{A_{ki}}{B_{ki}} = \frac{8\pi h\nu^3}{c^3}$

$$E_J = \frac{\hbar^2}{2I} J(J+1) \qquad I = I_0 e^{-bl} \qquad A = \log\frac{I_0}{I}$$

$$T = \frac{I}{I_0} \qquad \%T = 100T \qquad A = \varepsilon cl$$

g = 9.81 ms^{-2}
L = 6.022×10^{23} mol^{-1}
R = 8.3145 J K^{-1} mol^{-1} = 0.082057 atm dm^3 K^{-1} mol^{-1} = 1.98719 cal K^{-1} mol^{-1}
k_B = 1.381×10^{-23} J K^{-1}
F = 96485 C mol^{-1}
e = 1.602×10^{-19} C
ε_0 = 8.854×10^{-12} C^2 N^{-1} m^{-2}
m_e = 9.109×10^{-31} kg
1 amu = 1.661×10^{-27} kg
a_0 = 0.5292 Å
c = 2.9979×10^8 ms^{-1}
h = 6.626×10^{-34} Js $\hbar = 1.05457 \times 10^{-34} J \cdot s$
$R_H = 1.0968 \times 10^7 1/m$

1 atm = 101325 Pa = 760 Torr, 1 bar = 100000 Pa
1 m^3 = 1000 liter = 1000 dm^3 = 1000000 cm^3
1 M = 1mol/liter 1m = 1mol/kg
1 W = 1 J s^{-1} 1 A = 1000 mA 1 S = 1/Ω = 1 A/V 1 C = 1 A s
1 nm = 10^{-9} m, 1 Å = 10^{-10} m