

**§§§ New Formula XJ-7 §§§ Super Power (Batteries Sold Separately)**

$$PV = nRT \quad \alpha = \frac{1}{V} \left( \frac{\partial V}{\partial T} \right)_P \quad \kappa_T = -\frac{1}{V} \left( \frac{\partial V}{\partial P} \right)_T \quad \frac{\alpha}{\kappa_T} = \left( \frac{\partial P}{\partial T} \right)_V$$

$$(P + a \frac{n^2}{V^2})(V - nb) = nRT \quad C_V = \left( \frac{\partial U}{\partial T} \right)_V \quad C_P = \left( \frac{\partial H}{\partial T} \right)_P$$

$$dU = TdS - PdV \quad \left( \frac{\partial T}{\partial V} \right)_S = - \left( \frac{\partial P}{\partial S} \right)_V \quad \left( \frac{\partial U}{\partial V} \right)_T = -P + T \left( \frac{\partial P}{\partial T} \right)_V$$

$$dH = TdS + VdP \quad \left( \frac{\partial T}{\partial P} \right)_S = \left( \frac{\partial V}{\partial S} \right)_P \quad \left( \frac{\partial H}{\partial P} \right)_T = V - T \left( \frac{\partial V}{\partial T} \right)_P = -\mu_{JT} C_P$$

$$dA = -SdT - PdV \quad \left( \frac{\partial S}{\partial V} \right)_T = \left( \frac{\partial P}{\partial T} \right)_V \quad \mu_{JT} = \left( \frac{\partial T}{\partial P} \right)_H$$

$$dG = -SdT + VdP \quad \left( \frac{\partial S}{\partial P} \right)_T = - \left( \frac{\partial V}{\partial T} \right)_P \quad C_P - C_V = \left[ P + \left( \frac{\partial U}{\partial V} \right)_T \right] \left( \frac{\partial V}{\partial T} \right)_P = \frac{\alpha^2}{\kappa_T} VT$$

$$\xi = \frac{-w}{q_H} = \frac{q_H + q_L}{q_H} \quad \oint \frac{dq}{T} \leq 0 \quad \Delta S \geq \int \frac{dq}{T} \quad \Delta_r S_{T_2} = \Delta_r S_{T_1} + \Delta_r C_p \ln \frac{T_2}{T_1}$$

$$\left( \frac{\partial S}{\partial T} \right)_V = \frac{C_V}{T} \quad \left( \frac{\partial S}{\partial T} \right)_P = \frac{C_P}{T} \quad \Delta S = C_V \ln T_2/T_1 \quad \Delta S = C_P \ln T_2/T_1$$

$$\Delta S = \int \frac{\alpha}{\kappa_T} dV \quad \Delta S = - \int \alpha V dP \quad \Delta S = nR \ln V_2/V_1 \quad \Delta S = -nR \ln P_2/P_1$$

$$S^\circ = S^\circ_0 + \int_0^{T_{low}} \frac{AT^3}{T} dT + \int_{T_{low}}^{T_{melt}} \frac{C_p(s)}{T} dT + \frac{\Delta_{melt} H_m^\circ}{T_{melt}} + \int_{T_{melt}}^{T_{bp}} \frac{C_p(l)}{T} dT + \frac{\Delta_{vap} H_m^\circ}{T_{bp}} + \int_{T_{bp}}^T \frac{C_p(g)}{T} dT$$

$$\Delta G = nRT \ln P_2/P_1 \quad \left( \frac{\partial G/T}{\partial T} \right)_P = -\frac{H}{T^2} \quad \frac{\Delta_r G_{T_2}}{T_2} - \frac{\Delta_r G_{T_1}}{T_1} = \Delta_r H^\circ \left( \frac{1}{T_2} - \frac{1}{T_1} \right)$$

$$dG = -SdT + VdP + \sum \mu_i dn_i \quad G = \mu_A n_A + \mu_B n_B \quad \left( \frac{\partial \mu}{\partial T} \right)_P = -S_m \quad \left( \frac{\partial \mu}{\partial P} \right)_T = V_m$$

$$\frac{dP}{dT} = \frac{\Delta_{tr} S_m}{\Delta_{tr} V_m} = \frac{\Delta_{tr} H_m}{T_{tr} \Delta_{tr} V_m} \quad d \ln P = -\frac{\Delta_{tr} H_m}{R} d\frac{1}{T} \quad \ln \left( \frac{P_2}{P_1} \right) = -\frac{\Delta_{tr} H_m}{R} \left( \frac{1}{T_2} - \frac{1}{T_1} \right)$$

$$\Delta T_{melt} = \frac{T \Delta V_m}{\Delta_{melt} H_m} \Delta P \quad C_{p,m} = T \left( \frac{\partial S_m}{\partial T} \right)_P \quad \left( \frac{\partial \Delta_{tr} \mu}{\partial T} \right)_P = \left( \frac{\partial \mu_\beta}{\partial T} \right)_P - \left( \frac{\partial \mu_\alpha}{\partial T} \right)_P$$

$$\Delta_{tr} S_m = - \left( \frac{\partial \Delta_{tr} \mu}{\partial T} \right)_P \quad \Delta_{tr} V_m = \left( \frac{\partial \Delta_{tr} \mu}{\partial P} \right)_T = \left( \frac{\partial \mu_\beta}{\partial P} \right)_T - \left( \frac{\partial \mu_\alpha}{\partial P} \right)_T$$

$$V = V_A n_A + V_B n_B \quad dV_A = \frac{-x_B}{1-x_B} dV_B \quad \Delta_{mix} G = n_A (\mu_A(x_A) - \mu_A^*(l)) + n_B (\mu_B(x_A) - \mu_B^*(l))$$

$$\Delta_{mix} S = -nR \sum x_i \ln x_i \quad \Delta_{mix} G = nRT \sum x_i \ln x_i$$

$$\mu(g) = \mu^\circ(g) + RT \ln P/P^\circ \quad \mu_A(g) = \mu_A^\circ(g) + RT \ln P_A/P^\circ \quad \mu_A^*(l) = \mu_A^\circ(g) + RT \ln P_A^*/P^\circ$$

$$\mu_A(x_A) = \mu_A^\circ(g) + RT \ln P_A/P^\circ \quad \mu_A(x_A) = \mu_A^*(l) + RT \ln P_A/P_A^* \quad \mu_A(x_A) = \mu_A^*(l) + RT \ln x_A$$

$$\mu_B(x_B) = \mu_B^\dagger(l) + RT \ln x_B \quad \mu_B^\dagger(l) = \mu_B^\circ(g) + RT \ln K_B/P^\circ$$

$$\ln x_A = \frac{\Delta_{\text{vap}}H_A}{R} \left( \frac{1}{T} - \frac{1}{T_b^*} \right) \quad T = T^* + \frac{RT^{*2}}{\Delta_{\text{melt}}H_A} \ln x_A \quad \Delta T = \left( \frac{RT_b^2 \mathcal{M}_A}{1000 \Delta_{\text{vap}}H_A} \right) m_B$$

$$\pi V_{A,m}^* = -RT \ln x_A$$

$$\pi V_{A,m}^* = x_B RT$$

$$\pi = c_B RT$$

$$\mu_B = {}^x\mu_B^\dagger + RT \ln {}^x a_B$$

$${}^x a_B = {}^x\gamma_B x_B$$

$${}^x\mu_B^\dagger = \mu_B^\dagger \quad {}^x\gamma_B = \gamma_B$$

$$\mu_B = {}^c\mu_B^\circ + RT \ln {}^c a_B$$

$${}^c a_B = {}^c\gamma_B c_B/c^\circ$$

$$\mu_B = {}^m\mu_B^\circ + RT \ln {}^m a_B \quad {}^m a_B = {}^m\gamma_B m_B/m^\circ$$

$$\phi \equiv - \frac{\ln a_A}{m_B (\partial \ln a_A / 1000 \text{ g kg}^{-1})}$$

$$\phi = - (55.51 \text{ mol kg}^{-1} \ln a_A) / m_B$$

$$\ln a_A = -\phi m_B / (55.51 \text{ mol kg}^{-1})$$

$$\mu_A(x_A) = \mu_A^*(l) - RT \phi m_B / (55.51 \text{ mol kg}^{-1})$$

$$\phi = \frac{\Delta_{\text{fus}}H_A}{R m_B / (55.51 \text{ mol kg}^{-1})} \left( \frac{1}{T} - \frac{1}{T_m^*} \right)$$

$$\pi V_A = RT \phi m_B / (55.51 \text{ mol kg}^{-1})$$

$$d \ln {}^m\gamma_B = d\phi + \frac{\phi - 1}{m_B} d m_B$$

$$\ln {}^m\gamma_B = \phi - 1 + \int_0^m \frac{\phi - 1}{m_B} d m_B$$

$$K_p = K_c \left( \frac{c^\circ RT}{P^\circ} \right)^{\Delta_r n_g} \quad K_p = K_x \left( \frac{P}{P^\circ} \right)^{\Delta_r n_g} \quad K_p = \frac{\xi^2}{a^2 - \xi^2} \left( \frac{P}{P^\circ} \right) \quad \ln \left( \frac{K_p(T_2)}{K_p(T_1)} \right) = - \frac{\Delta_r H^\circ}{R} \left( \frac{1}{T_2} - \frac{1}{T_1} \right)$$

$$\left( \frac{\partial G}{\partial \xi} \right)_{T,P} = \sum_{i=1}^{n_s} \nu_i G_i = \Delta_r G$$

$$\left( \frac{\partial \left( \frac{\Delta_r G^\circ}{T} \right)}{\partial T} \right)_p = - \frac{\Delta_r H^\circ}{T^2}$$

$$\left( \frac{\partial \ln K_p}{\partial T} \right)_p = \frac{\Delta_r H^\circ}{RT^2}$$

$$\ln \frac{K_{p,T_2}}{K_{p,T_1}} = - \frac{\Delta_r H^\circ}{R} \left( \frac{1}{T_2} - \frac{1}{T_1} \right) + \frac{\Delta_r C_p}{R} \ln \frac{T_2}{T_1}$$

$$\ln K_p = - \frac{\Delta_r H^\circ}{RT} + \frac{\Delta_r a}{R} \ln T + \frac{\Delta_r b}{2R} T + \frac{\Delta_r c}{6R} T^2 + I$$

$$\ln \frac{K_{p,T_2}}{K_{p,T_1}} = - \frac{\Delta_r H^\circ}{R} \left( \frac{1}{T_2} - \frac{1}{T_1} \right) + \frac{\Delta_r a}{R} \ln \frac{T_2}{T_1} + \frac{\Delta_r b}{2R} (T_2 - T_1) + \frac{\Delta_r c}{6R} (T_2^2 - T_1^2)$$

$$\Delta_{\text{dilution}}G = RT \ln a_2/a_1$$

$$\Delta_r G^{\circ'} = \Delta_r G^\circ + \nu_{H^+} RT \ln 10^{-7}$$

$$\log \gamma_{\pm} = -1.825 \times 10^6 |z_+ z_-| \left( \frac{d}{\epsilon^3 T^3} \right)^{1/2} (I/m^\circ)^{1/2} \quad \log \gamma_{\pm} = -0.509 |z_+ z_-| I^{1/2} \quad \ln \gamma_{\pm} = -1.171 |z_+ z_-| I^{1/2}$$