

Second Exam
March 4, 2009

First Page: Useful information and equations:

Law I $\Delta U = q + w$

$$U = U(T, V)$$

$$dU = \left(\frac{\partial U}{\partial T} \right)_V dT + \left(\frac{\partial U}{\partial V} \right)_T dV$$

Law II: $dS = \frac{q_{rev}}{T}$

$$S = S(T, V)$$

$$dS = \left(\frac{\partial S}{\partial T} \right)_V dT + \left(\frac{\partial S}{\partial V} \right)_T dV$$

Comb I, II: $dU = TdS - PdV$

$$H = U + PV; \quad A = U - TS$$

$$G = H - TS; \quad dG = -SdT + VdP$$

Thermodynamic Equation of State

$$\left(\frac{\partial H}{\partial P} \right)_T = V - T \left(\frac{\partial V}{\partial T} \right)_P$$

$$\left(\frac{\partial S}{\partial T} \right)_P = \frac{C_P}{T}; \quad \left(\frac{\partial S}{\partial P} \right)_T = - \left(\frac{\partial V}{\partial T} \right)_P;$$

$$\mu_A = \mu_A^\circ + RT \ln \frac{P_A}{P^\circ}$$

Dalton's and Raoult's Laws

$$P_A = \chi_A P_A^*; \quad P_A = y_A P_{Tot}; \quad P_A = \chi_A k_{H,A}$$

$$P_{Tot} = \sum_A P_A; \quad G = \sum n_i \mu_i$$

$$\Delta G_{mix} = RT \sum n_i \ln \left(\frac{P_i}{P^\circ} \right)$$

Integral Identity:

$$\Delta Z = \int_{x_i}^{x_f} \left(\frac{\partial Z}{\partial x} \right)_y dx$$

$$\text{Cyclic rule: } \left(\frac{dx}{dy} \right)_z \left(\frac{dz}{dx} \right)_y \left(\frac{dy}{dz} \right)_x = -1$$

Chain Rules:

$$\frac{d(yz)}{dx} = z \frac{d(y)}{dx} + y \frac{d(z)}{dx}$$

$$\frac{dx}{dz} = \frac{dy}{dz} \frac{dx}{dy}; \quad \left(\frac{\partial x}{\partial z} \right)_a = \left(\frac{\partial y}{\partial z} \right)_a \left(\frac{\partial x}{\partial y} \right)_a$$

$$\text{vdW Gas EoS: } P = \frac{RT}{V_m - b} - \frac{a}{V_m^2}$$

Reaction Info

$$\Delta H_{rxn}^\circ = \sum_i \nu_i \Delta H_f^\circ(i)$$

$$\Delta S_{rxn}^\circ = \sum_i \nu_i S_f^\circ(i)$$

$$dn_i = n_i - n_i^{init} = \nu_i dX$$

$$\Delta C_{P,rxn} = \sum_i \nu_i C_{P,m}(i)$$

$$\Delta H^\circ = \Delta H_{rxn}^\circ dX$$

$$\Delta G_{rxn} = \Delta G_{rxn}^\circ + RT \ln Q_P = RT \ln \frac{Q_P}{K_P}$$

$$Q_P = \prod_{i=1}^N \left(\frac{P_i}{P^\circ} \right)^{\nu_i} \quad @ \text{Eq } Q_P = K_P$$

$$K_P = \left(\frac{P}{P^\circ} \right)^{\Delta \nu} \quad K_c = \left(\frac{c_o RT}{P^\circ} \right)^{\Delta \nu} K_P$$

Van't Hoff Eqn:

$$\ln \left(\frac{K_P(T_2)}{K_P(T_1)} \right) = - \frac{\Delta H_{rxn}^\circ}{R} \left(\frac{1}{T_2} - \frac{1}{T_1} \right)$$

Gas Constant:

$$R = 8.3 \text{ J / mol - K}$$

$$101 \text{ J} = 1 \text{ l - Atm}$$

$$R = 0.082 \text{ l - Atm / mol - K}$$

$$R \cdot 298.15 = 2.48 \text{ kJ / mol}$$

$$g = 9.8 \text{ m/sec}^2; \quad \rho_{(H_2O, \ell)} = 1 \text{ g/cc}$$

$$P = \rho gh$$

$$1 \text{ bar} = 10^5 \text{ Pa}$$

$$T(K) = T(C) + 273.15$$

Show your work throughout; clearly show what equations you are using, and always show units for computed quantities.