Chem 331, Physical Chemistry I Final

Monday, December 14, 2007

200 points total

Definitions: $H = U + PV$ $\quad A = U - TS$ $\quad G = H - TS$

Properties of Matter:

$$C_v = \left(\frac{\partial U}{\partial T}\right)_V \qquad C_P = \left(\frac{\partial H}{\partial T}\right)_P \qquad \mu_{JT} = \left(\frac{\partial T}{\partial P}\right)_H$$

$$\beta = \frac{1}{V}\left(\frac{\partial V}{\partial T}\right)_P \qquad \kappa = -\frac{1}{V}\left(\frac{\partial V}{\partial P}\right)_T \qquad \frac{\beta}{\kappa} = \left(\frac{\partial P}{\partial T}\right)_V$$

Fundamental equations

$$\mathrm{d}U = TdS - PdV + \sum \mu_i dn_i$$

$$\mathrm{d}A = -SdT - PdV + \sum \mu_i dn_i$$

$$\mathrm{d}H = TdS + VdP + \sum \mu_i dn_i$$

$$\mathrm{d}G = -SdT + VdP + \sum \mu_i dn_i$$

$$dS = \frac{dq_{rev}}{T}$$

Maxwell relations

$$\left(\frac{\partial P}{\partial S}\right)_V = -\left(\frac{\partial T}{\partial V}\right)_S$$

$$\left(\frac{\partial P}{\partial T}\right)_V = \left(\frac{\partial S}{\partial V}\right)_T$$

$$\left(\frac{\partial T}{\partial P}\right)_S = \left(\frac{\partial V}{\partial S}\right)_P$$

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

Some derived relations:

$$\frac{dP}{dT} = \frac{\Delta \bar{H}}{T \Delta \bar{V}}, \qquad \left(\frac{T_f}{T_i}\right) = \left(\frac{V_f}{V_i}\right)^{1-\frac{C_p}{C_v}} \qquad \frac{d(\ln P)}{d(1/T)} = -\frac{\Delta \bar{H}}{R} \quad , \; C_p - C_v = n\mathrm{R}$$

$$\frac{d \ln K}{dT} = \frac{\Delta H_r^\circ}{RT^2}; \quad \left(\frac{\partial G/T}{\partial T}\right)_P = -\frac{H}{T^2} \qquad \Delta G_r = \Delta G_r^\circ + RT \ln Q$$

$$\gamma_i^R = \frac{P_i}{x_i P_i^*}, \; \gamma_i^H = \frac{P_i}{x_i k_i}, \; a_{x,i} = \gamma_i x_i, \; a_{m,i} = \gamma_i m_i, \; a_i = \frac{P_i}{P_i^*}, \; f_i = \phi_i P_i \; ; \qquad \nu = \nu_+ + \nu_-$$

$$a(A_{\nu+}B_{\nu-}) = a_\pm^\nu = (\gamma_\pm m_\pm)^\nu \; ; \; \gamma_\pm = \left(\gamma_+^{\nu_+}\gamma_-^{\nu_-}\right)^{1/\nu}, \; m_\pm = \left(m_+^{\nu_+} m_-^{\nu_-}\right)^{1/\nu} = \left(\nu_+^{\nu_+}\nu_-^{\nu_-}\right)^{1/\nu} m$$

$$I = \tfrac{1}{2}\sum m_i z_i^2, \; \ln \gamma_\pm = 1.173 z_+ z_- \sqrt{I} \quad , \qquad \mu_i = \mu_i^o + RT \ln a_i \quad , \quad \sum n_i d\mu_i = 0$$

$$\mathrm{R} = 8.3145 \text{ J K}^{-1} \text{ mol}^{-1} = 0.082058 \text{ L atm K}^{-1} \text{ mol}^{-1}; \; 1 \text{ bar} = 10^5 \text{ Pa}$$