Second Exam
February 29, 2008

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: \( dS = \frac{q_{\text{rev}}}{T} \)
\[ S = S(T,V) \]
\[ dS = \left( \frac{\partial S}{\partial T} \right)_V dT + \left( \frac{\partial S}{\partial V} \right)_T dV \]

Comb I, II: \( dU = T dS - P dV \)
\[ H = U + PV; \quad A = U + PV \]
\[ G = H - TS; \quad dG = -TdS + VdP \]

Thermodynamic Equation of State
\[ \left( \frac{\partial H}{\partial T} \right)_P = V - T \left( \frac{\partial V}{\partial T} \right)_P \]
\[ \left( \frac{\partial S}{\partial T} \right)_P = C_p; \quad \left( \frac{\partial S}{\partial P} \right)_T = - \left( \frac{\partial V}{\partial T} \right)_P \]
\[ \mu_A = \mu_A^0 + RT \ln \frac{P_A}{P_o} \]

Dalton’s Law
\[ P_A = \chi_A P; \quad P = \sum_A P_A; \quad G = \sum n_i \mu_i \]

\[ \Delta G_{\text{mix}} = RT \sum n_i \ln \left( \frac{P_i}{P_o} \right) \]

Calculus Identities:
\[ \Delta Z = \int_z^x \left( \frac{\partial Z}{\partial x} \right)_y \, dx \]
\[ \left( \frac{dz}{dy} \right)_x \left( \frac{dy}{dx} \right)_x = -1 \]
\[ \frac{d(yz)}{dx} = z \frac{d(y)}{dx} + y \frac{d(z)}{dx} \]
\[ \frac{dx}{dz} \frac{dy}{dz} \frac{dz}{dx} = \left( \frac{\partial x}{\partial z} \right)_a \left( \frac{\partial y}{\partial z} \right)_a \]

Thermal expansion and compression coefficient
\[ \beta = \frac{1}{V} \left( \frac{\partial V}{\partial T} \right)_p \]
\[ \kappa = \frac{-1}{V} \left( \frac{\partial V}{\partial P} \right)_T \]
vdW Gas EoS: \( P = \frac{RT}{V_m - b} - \frac{a}{V_m^2} \)

Reaction Info
\[ \Delta H_{\text{rxn}}^o = \sum_i v_i \Delta H_f^o \]
\[ \Delta S_{\text{rxn}}^o = \sum_i v_i S_f^o \]
\[ dn_i = n_i - n_i^{\text{init}} = v_i dX \]
\[ \Delta C_{P,\text{rxn}} = \sum_i v_i C_{P,m} \]

\[ \Delta H^o = \Delta H_{\text{rxn}}^o dX \]
\[ \Delta G_{\text{rxn}} = \Delta G_{\text{rxn}}^o + RT \ln Q_p = RT \ln \left( \frac{Q_p}{K_p} \right) \]
\[ Q_p = \prod_{i=1}^N \left( \frac{P_i}{P_o} \right)^{v_i} \quad \text{at Eq } Q_p = K_p \]
\[ K_p = \left( \frac{P}{P_o} \right)^{\Delta v} \]

Van’t Hoff Eqn:
\[ \ln \left( \frac{K_p(T_2)}{K_p(T_1)} \right) = - \frac{\Delta H^o_{\text{rxn}}}{R} \left( \frac{1}{T_2} - \frac{1}{T_1} \right) \]

Gas Constant:
\[ R = 8.31 \text{J/mol} - \text{K} \]
\[ R = 0.08 \text{L-atm/mol-K} \]
\[ R \cdot 300 \text{K} = 2.5 \text{kJ/mol} \]
\[ 1\text{Atm} \approx 1\text{bar} = 10^5 \text{Pa} \]
\[ T(K) = T(\text{C}) + 273 \]

Show your work throughout; clearly show what equations you are using, and always show units for computed quantities.
Show your work throughout, always write down the equations you are using before substituting in numerical values and always show units for computed quantities. You do not need to compute the final number if you do not want to but you must show where the numbers you are given can be used.

Use this page for additional space if you need it.