

**Problems: Q6.4, Q6.7, P6.5, P6.6, P6.8**

HW7A

Due Friday (02/22/08)

**Q6.4)** By invoking the pressure dependence of the chemical potential, show that if a valve separating a vessel of pure A from a vessel containing a mixture of A and B is opened, mixing will occur. Both A and B are ideal gases, and the initial pressure in both vessels is 1 bar.

**Q6.7)** The reaction  $A + B \rightarrow C + D$  is at equilibrium for  $\xi = 0.1$ . What does this tell you about the variation of  $G_{pure}$  with  $\xi$ ? [Assume the reaction contains equimolar amounts of A and B]

**P6.5)** The pressure dependence of  $G$  is quite different for gases and condensed phases. Calculate  $G_m(\text{C, solid, graphite, 100 bar, 298.15 K})$  and  $G_m(\text{He, g, 100 bar, 298.15 K})$  relative to their standard state values. By what factor is the change in  $G_m$  greater for He than for graphite?

**P6.6)** Assuming that  $\Delta H_f^\circ$  is constant in the interval 275 K – 600 K, calculate

$\Delta G_f^\circ(\text{H}_2\text{O, g, 525 K})$ . Plot  $\frac{\Delta G_f^\circ(T)}{T}$  as a function of  $\frac{1}{T}$  over this temperature interval. What is the Intercept, and what is the slope of this line in terms of  $\Delta H_f^\circ$  and  $\Delta S_f^\circ$ ?

**P6.8A+)** Calculate  $\Delta A_{reaction}^\circ$  and  $\Delta G_{reaction}^\circ$  for the combustion of methane (whose reaction is  $\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l})$ ) at 298 K from the combustion enthalpy of methane and the entropies of the reactants and products. Assume the ideal gas approximation to convert between the Helmholtz and the Gibbs free energies.

**6.8 B)** Assume the initial mixture consists of 0.2 moles of methane and 4 moles of all other species involved in the reactions (including the products) in a vessel held at constant P and T (as standard conditions). What is the free energy change of the system if all of the methane is consumed? [Ignore the contribution of the change in mole fractions to the  $\Delta G_{reaction}$  and ignore  $\Delta G_{mixture}$ . Later we will consider what happens to  $\Delta G_{mixture}$  under the assumption of all methane consumed?]

**6.8C)** How many moles of each reaction species are present at the end of the reaction carried out in part B?

**6.8D)** What is the actual heat generated by the reaction of part B?