CH353 – Physical Chemistry I
Spring 2013, Unique 51170

Homework, Week 9

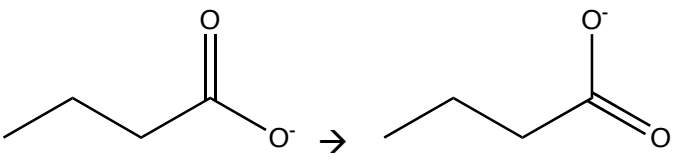
1. Based on your general chemistry knowledge, determine whether the chemical potential of the reactants in the following balanced equations is greater than, less than, or equal to the chemical potential of the products. You may assume each reaction is taking place under standard conditions unless otherwise indicated.

a) $NaCl(s) \rightarrow Na^+(aq) + Cl^-(aq)$

b) $HCl(aq) \rightarrow H^+(aq) + Cl^-(aq)$

c) $H_2O(l) \rightarrow H_2O(g)$ at T = 373 K

d) $O_2(g) \rightarrow 2\ O\ (g)$

e) 

2. Consider a system consisting of n_1 moles of component 1 and n_2 moles of component 2. Derive an expression for the Gibbs free energy of this system.

3. At 25˚C, the density of a 50% (m/m) solution of ethanol and water is 0.914 g cm^{-3}. Given that the partial molar volume of water in the solution is 17.4 cm^3 mol^{-1}, determine the partial molar volume of the ethanol.

4. What proportions of hexane and heptane should be mixed by mole fraction to achieve the greatest entropy of mixing?

5. The molar enthalpy of fusion of ice at 273.15 K and 1.0 atm is 6010 J mol^{-1}. The change in volume caused by the fusion of ice under the same conditions is -1.63 cm^3 mol^{-1}. You may assume that these values remain constant as a function of pressure. Estimate the melting temperature of ice at 1000 atm.

6. When a solution of acetone (A) and methanol (M) are in equilibrium at 57.2˚C at 1.0 atm, the mole fraction of acetone in the liquid phase was found to be 0.40, while the mole fraction of

acetone in the vapor phase was found to be 0.516. Determine the vapor pressures of both liquids and comment on your answer. For these two components, P^*_A = 105 kPa and P^*_M = 73.5 kPa.

7. A liquid mixture is composed of two liquids A and B. At 60 ˚C, the pure vapor pressure of A is 400 Torr and the pure vapor pressure of B is 800 Torr. The total mixture contains 1 mole of A and 4 moles of B. At 60 ˚C and a total pressure of 650 Torr, is the mixture all liquid, all vapor, or in a liquid-vapor equilibrium? Justify your answer.

8. Draw a temperature-composition diagram of a binary system in terms of the mole concentration of species 1 in which species 1 is the more volatile component. Label the regions of the diagram in which liquid and vapor phases exist.

9. In class, we examined an ideal solution formed between 1-propanol and 2-propanol:

P^*(1-propanol) = 20.9 Torr
P^*(2-propanol) = 45.2 Torr (at 25˚C)

Construct a pressure-composition diagram for this solution in terms of the mole fraction of 2-propanol in both the liquid and vapor phases. Label the regions of the diagram in which liquid, vapor, and liquid-vapor phases exist. If the mole fraction of 2-propanol in the liquid phase is 0.6, what is the composition of the vapor phase?