Homework, Week 9

1. 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.

2. 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.

3. Explain the driving force for equilibrium and why spontaneous reactions rarely go to completion. Use words, diagrams, and equations, and be precise.

4. 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.

5. 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?

6. Concentrated sulfuric acid is sold as a solution that is 98.0% sulfuric acid and 2.0% water by mass. Given that the density of the solution is 1.84 g/mL, calculate the molarity of concentrated sulfuric acid.