Name: _____ Test 3

140 points Chemistry 261

Dr. Jay H. Baltisberger April 28, 1999

Answer the following multiple choice questions for 10 points each.
Must show complete work for full credit to be given:

1. The vapour pressure of a liquid between 15˚C and 35˚C fits the expression log(p/Torr) = 8.750 – 1625 K / T. Calculate the enthalpy of vaporization of this liquid.

   A) 8.75 J / mol **B)** 1625 J / mol **C)** 72.8 J / mol **D)** 13.5 kJ / mol **E)** 195 J / mol

2. At 300 K, the partial vapour pressure of HCl in liquid $GeCl_4$ is 121.8 kPa when x_{HCl} is 0.019. Calculate the Henry's Law constant for this mole fraction.

   A) 2.314 kPa **B)** 0.406 kPa / K **C)** 6410 kPa **D)** 21.4 kPa / K **E)** 7.71 Pa / K

3. If the vapour pressure of pure A and B are 121.0 kPa and 321.2 kPa respectively and the solution of A and B is ideal, calculate the mole fraction of A in the vapour at equilibrium if the liquid has an initial mole fraction of A = 0.332.

   A) 0.842 **B)** 0.377 **C)** 0.332 **D)** 0.187 **E)** 0.157

BOTH of the following two exercises for 15 points each:

4. The osmotic pressure of a solution of a compound in benzene (ρ = 0.879 g / cm^3, MW = 78.11 g / mol, K_f = 5.12 K kg / mol, T_f = 278 K) at 288 K is 99.0 kPa (101325 Pa = 1 atm). Calculate the freezing point of the solution.

5. Sketch the phase diagram of the system NH_3/N_2H_4 given that the two substances do not form a compound with each other, that NH_3 freezes at –78˚C and N_2H_4 freezes at +2˚C, and that a eutectic is formed when the mole fraction of N_2H_4 is 0.07 and that the eutectic melts at –80˚C. Use graph paper to make an accurate/precise plot.

Choose two of the following three problems for 40 points each:

6. The volume of an aqueous solution of NaCl at 25˚C was measured at a series of molalities (*b*), and it was found that the volume fitted the expression:

   $$V/cm^3 = 1003 + 16.62\ b + 1.77\ b^{3/2} + 0.12\ b^2$$

   where V is the volume of a solution formed from 1.000 kg of water and b is to be understood as b / b˚. Calculate the partial molar volume of the components in a solution of molality 0.0500 mol / kg.

7. Calculate the difference in slope of the chemical potential against pressure on either side of (a) the normal freezing point and (b) normal boiling point of water. The densities of ice and water at 0˚C are 0.917 and 1.000 g / cm^3 respectively, and those of water and water vapour at 100˚C are 958 and 0.598 g / L respectively. By how much does the chemical potential of water vapour exceed that of liquid water at 1.2 atm and 100˚C?

8. Draw the phase diagram for the mixture of $FeCl_2$ (T_f = 677˚C) and KCl (T_f = 776˚C) which form compounds $KFeCl_3$ and K_2FeCl_4 at elevated temperatures. $KFeCl_3$ melts congruently at 380˚C and K_2FeCl_4 melts incongruently at 399˚C. Eutectics form with compositions of x = 0.380 (melting at 351˚C) and x = 0.540 (melting at 393˚C) where x is the mole fraction of $FeCl_2$. .The KCl solubility curve intersects the K_2FeCl_4 curve at x = 0.340. Sketch the cooling curve from 400˚C to 300˚C for a mole fraction of $FeCl_2$ of 0.360, indicating compositions of phases present in each region of the cooling curve.