Colligative Properties Problems

1. A solution contains 30.0 g of $CHCl_3$ and 70.0 g of CCl_4 at 27°C. At this temperature, the vapour pressures of pure $CHCl_3$ and pure CCl_4 are 214 mmHg and 124 mmHg respectively.
   a) Assume ideal behaviour and calculate the partial pressure due to each solvent above the solution. **[P_{CHCl3} = 76.1 mmHg; P_{CCl4} = 79.9 mmHg]**
   b) Calculate the composition of the vapour above the solution. **[X_{CHCl3} = 0.488; X_{CCl4} = 0.512]**

2. A 0.10 mol sample of urea ($(NH_2)_2CO$) is dissolved in 100.0 grams of water at 25°C. Given that the vapour pressure of pure water is 23.8 mmHg at 25°C, and that the k_f and k_b for water are 1.86°C/*m* and 0.512°C/*m* respectively, estimate:
   a) The vapour pressure of the solution at 25°C. **[23.38 mmHg]**
   b) The boiling point of the solution. **[100.512°C]**
   c) The freezing point of the solution. **[-1.86°C]**

3. A 0.100 *m* aqueous H_3PO_4 solution freezes at -0.230°C. Calculate the van't Hoff *i* factor and use it to estimate the boiling point of the solution. The k_f for water is 1.86°C/*m*, and k_b is 0.512°C/*m*. **[*i* = 1.24; 100.0633°C]**

4. A 0.100 *m* solution of a certain monoprotic weak acid has a freezing point of –0.1933°C. What is K_a for the weak acid? The k_f for water is 1.86°C/*m*. **[1.60 x 10^{-4}]**

5. Calculate the freezing point of a 0.0100 *m* solution of acetic acid, assuming that it does not ionize. The actual experimental of this solution has been reported as -0.0195°C. What fraction of the acetic acid molecules is ionized? **[-0.0186°C; 4.84%]**