Homework Set 4

CH 353, Vanden Bout, Summer 2010

Chapter 24

16, 18, 20, 26 (note this is not and ideal solution. Don't use Raoult's law. Use the formula that is given in the problem)

Chapter 25

4, 26, 43

1
You make and ideal binary mixture of two liquids **A** & **B** and divide it into two parts. At a particular pressure, you test half the mixture. When heated it begins to boil at 60°C. The vapor above the boiling solution has 3 times as many moles of **A** compared to moles of **B** ($P_A = 3P_B$). The vapor pressure of pure **A** and **B** are 550 Torr and 150 Torr respectively at 60°C. The second half of the solution is heated under a lower pressure, the mixture begins to boil at 40°C. At 40°C the vapor contains only 2.5 times as many moles of **A** than **B** ($P_A = 2.5P_B$). The vapor pressure of pure **B** at 40°C is 100 Torr. What is the vapor pressure of pure **A** at 40°C? What is the pressure at which the solution begins to boil at 40°C?

2. Below is a table of the vapor pressures of benzene and toluene at a series of temperatures.

T (°C)	79.4	88	94	100	110
P^*_{C6H6} (bar)	1.00	1.285	1.526	1.801	
P^*_{C7H8} (bar)		0.508	0.616	0.742	1.000

Calculate the composition of the vapor and liquid of a mixture of benzene and toluene at these temperatures. Make a plot of the phase diagram for this mixture as temperature vs composition. If you were going to distall a mixture that was half benzene and half toluene (0.5 mole fraction each), at what temperature would the first drop of vapor form? What would the composition of the vapor be?

3. What is the boiling point, freezing point and osmotic pressure of a solution of 1 L of water with 10 g of NaCl in it? Note: NaCl will become Na+ and Cl- in solution effectively doubling the effect on the salt on the colligative properties.

4.

Having finished 353 you get a job working in an analytical chemistry lab. Your first assignment is to determine the molecular weight of a very rare and expensive extract from a gland of a small South American frog. Having not taken CH376 you decide to blow off mass spectrometry as an approach and instead will use freezing point depression. You dissolve all 0.5g of the substance that you have in methanol. Not having a lot of equipment at your disposal you decide to put the mixture in a nice big coffee mug that is handy. It makes a lovely brown mixture and you are amused that looks kind of like very very weak coffee. Right after you dump the compound in, you regret your decision as methanol normally has a freezing point of –97.95°C. You'll have to get it really cold. You decide to take the cup with you to another lab to think about how you'll get the mixture so cold. Unfortunately, as you are headed next door you spill some of the solution. You watch helplessly as if flows down the floor drain. You note you lost 25 mL of the solution to the floor. When you get next door, you decide that with a heater, some liquid nitrogen, and a bit of absolute ethanol (mp –114) you'll be able to make a temperature bath that can go down to low enough temperatures. Your elation at finding a scheme to go to low temperatures is crushed by the sight of your lab partner Francis pouring a pack of sugar into the mixture in the coffee mug. You scream and he stops pouring the sugar and shouts "can't a guy have a cup of coffee in peace." In his excitement he spills about 50 mL of the solution onto the floor. As you watch helplessly, it runs away down a floor drain. You curse the floor drains. You tell him to go weigh the sugar remaining in the package and a full package so you can figure out how much he has put in the "coffee". Exasperated you take the mug and set up the freezing temperature apparatus. The whole thing looks like something out of a bad movie. In the end you manage to measure the freezing point of 2 mL of the mixture, and you discover the freezing point of the mixture is now –98.7°C. You look over your lab book and here is what you know. Hank dumped in 2.05 g of sugar. The molecular weight of the sugar (sucrose) is 342 g mol^{-1}. Approximately 2,300 frogs were needed for the extraction of the substance. The total volume of the solution into which Hank dumped the sugar was 100 mL. You started the day with a volume of 125 mL of methanol. Your boss is extremely nasty and somehow hired you as an analytical chemist despite you having no training in the area. The density of methanol is .07866 g cm^{-3}. The barometric pressure outside that day was 1.001 atm. The enthalpy of fusion for methanol is 3.16 kJ mol^{-1}. The pure vapor pressure of pure methanol is 121 Torr at room temperature. The freezing point of 2 mL of the sugar and frog gland solution was -98.7°. What was the molecular weight of the compound?