CHEMISTRY 142 – Example Problems

Solutions and Colligative Properties

To be taken up in class or solutions will be posted

$N_A = 6.022 \times 10^{23}$	K_f (benzene) = 4.90 °C kg/mol	K_f (ethanol) = 1.99 °C kg/mol
density of H_2O = 1.00 g/mL	$K_f(CCl_4)$ = 31.8 °C kg/mol	$K_b(H_2O)$ = 0.51 °C kg/mol
K_f (H_2O) = 1.86 °C kg/mol	K_f (acetic acid) = 3.90 °C kg/mol	$P^o(H_2O)$ = 23.800 torr at 25°C

K_b (2-methyl-2-propanol) = 1.98°C kg mol^{-1} K_f (2-methyl-2-propanol) = 4.68°C kg mol^{-1}

1. Show that for very dilute solutions, molality ≅ Molarity.

2. Which will experience a greater freezing point depression, a 0.1 *m* solution of benzene in carbon tetrachloride or a 0.1 *m* solution carbon tetrachloride in benzene? Explain.

[benzene in CCl_4]

3. An aqueous sucrose (**$C_{12}H_{22}O_{11}$**) solution of unknown concentration is found to have a freezing point of -0.912 °C. What is the normal boiling point and the partial pressure (in torr) of water at 25°C of this solution. Sucrose is a non-volatile, non-electrolyte.

[BP =100.25°C; P_{H2O}=23.59 torr]

4. Pure 2-methyl-2-propanol has a freezing point of 25.50 °C, however it absorbs water (as an impurity) on exposure to humid air. If the freezing point of a 100.0 g sample of 2-methyl-2-propanol is 24.59 °C, how many grams of water are present in the sample?

[0.35 g H_2O]

5. Osmotic pressure is a colligative property that can be used to determine the molar mass of an unknown substance. The osmotic pressure is determined by measuring the height of the column of solution and converting this value to mm of Hg (1 mm Hg = 1 torr, 760 torr = 1 atm). Using, $\Pi V_{solution} = n_{solute} R T$ (where Π is the osmotic pressure, R is the universal gas constant and T is the Kelvin temperature), calculate the molar mass of insulin if 20.0 mg is dissolved in 10.0 mL of solution to give a resulting osmotic pressure of 6.48 torr at 25°C. *[5740 g/mol]*

6. Henry's Law constant for most gases decreases with increased temperature. Given that K_H for **O_2** is 2.20×10^{-3} M atm^{-1} at 5°C, calculate the percent **O_2**(aq) saturation if a lake water sample at 5°C and sea-level is found to contain, 9.20 mg/L of **O_2**(aq). (Recall: partial pressure of **O_2** at sea-level = 0.2095 atm). *[62.3 % sat^d]*

7. An Okanagan vintner (that's a winemaker) is waiting for her grapes to freeze in order to make a special batch of holiday ice-wine. Recent analysis has shown that the grapes are currently 28% sugar by mass. Assuming that sugar (formula **$C_6H_{12}O_6$**) is the only solute present and that water is the solvent, at what temperature will the grapes freeze?

[-4.0 °C]

8. Calculate the van't Hoff factor (*i*) for **HF** if the freezing point of a 0.50 *m* aqueous solution has a freezing point of –1.00°C. What percentage of the **HF** is dissociated at this concentration.

[i=1.07$_5$; 3.8% diss]