Chapter 13 Practice Problems

1. 5.12 g of $Mg(NO_3)_2$ is dissolved in 800.2g of water. The K_b for water is 0.512°C/m. Assume complete dissociation of the salt in solution.
   a. What is the boiling point elevation in °C? **0.0663 °C** At what temperature will the solution boil at 760 torr? **100.0663 °C**
   b. Would you expect the actual boiling point of this solution to be higher or lower than what you calculated? Explain. **Lower—ion pairs will decrease solute particle concentration**
   c. Would you expect a $NaNO_3$ solution of equal molality to that of $Mg(NO_3)_2$, above, to have a higher or lower boiling point than that of the magnesium nitrate solution, above? Explain **Lower—the sodium nitrate solution would have a lower solute concentration since one mole $NaNO_3$ dissociates in solution to produce two moles of ions (Na^+ and NO_3^-), while each mole of $Mg(NO_3)_2$ dissociates to produce 3 moles of ions.**

2. How many grams of ethanol, CH_3CH_2OH, are needed to raise the boiling point of 500.0 mL of water by 2.5°C? The boiling point elevation constant K_b = 0.512 °C/molality. **112.5 g ethanol = 110 g ethanol**

3. Assuming the van't Hoff factor for NaCl to be 1.84, calculate the freezing point of an aqueous 0.500 molal NaCl solution? For water, K_f = 1.86°C/m. **ΔT_f = 1.71 °C FP = -1.71 °C**

4. The solubility of an unknown gas in water at 20.°C is 0.20 g/L when the partial pressure of the gas above the solution is 200. torr. What is the solubility of the gas in g/L when its partial pressure is 300. torr? **0.300 g/ L (The solubility of a gas is directly proportional to its partial pressure above the solution)**

5. Vinegar is 5.0% acetic acid, CH_3COOH.
   a. Calculate the molarity, M, of vinegar if 5.0% is w/v. **0.8326 M = 0.83 *M* acetic acid**
   b. Calculate the molality, m, of vinegar if 5.0% is w/w. **0.8765 M = 0.88 *m* acetic acid**

6. A 20.0% (w/w) aqueous solution of HCl has a density of 1.10 g/mL. Calculate the molarity of the solution. **6.034 *M* = 6.03 *M* HCl**
7. How does each of the following affect the vapor pressure of a liquid in a closed container? Explain your responses.
   a. Decreasing the temperature → **decrease in VP**
   b. Increasing the volume of liquid →**no change in VP**
   c. Increasing the volume of the container at constant temperature →**no change in VP**
   d. The addition of a nonvolatile solute → **decrease in VP**
   e. The addition of a volatile solute → **decrease in VP of the solvent. (But the volatile solute will add to the total vapor pressure above the solution with the amount dependent on how volatile the solute is.)**

8. Ethylene glycol, a non-volatile liquid with formula $C_2H_6O_2$ and molar mass 62g/mol, is added to 2102g of water. At 89°C, the vapor pressure of this resulting solution is found to be 460 torr. How many grams of the non-volatile liquid were added to the water? The vapor pressure of pure water is 526 torr at 89°C. **1041 g = 1000 g ethylene glycol**

9. At 25 °C the vapor pressure for pure $CHCl_3$ is 172.0 torr, while that for pure CCl_4 is 98.3 torr. What is the vapor pressure of an ideal solution containing 61.1g of, $CHCl_3$, and 70.9g of carbon tetrachloride, CCl_4 at 25°C? **$P_T = P_{CHCl3} + P_{CCl4}$ = 90.5 torr + 46.58 torr = 137.1 torr**