1. (2 points) Colligative properties are similar in that they all depend on the
   a. chemical properties of the solute.
   b. number of particles dissolved.
   c. molar mass of the solute.
   d. chemical properties of the solvent.

2. (2 points) Which statement is false?
   a. The solubility of a gas in a liquid decreases as the temperature increases.
   b. The solubility of a gas in a liquid increases as the pressure of that gas over the liquid is increased.
   c. The vapor pressure of a solvent over a solution is larger than the vapor pressure over pure solvent.
   d. The freezing point of a solution decreases as the molality of its solute increases.

3. A solution is prepared by dissolving 10.0 g of NH₃ (17.03 g/mol) in 90.0 g of water (18.02 g/mol). The resulting solution has a density of 0.982 g/mL.
   a. (4 points) Calculate the molality of NH₃ in the solution.
      \[
      \text{molality} = \frac{\text{mass of solute}}{\text{mass of solvent}} \times \text{molarity of solute} = \frac{10.0 \text{ g NH}_3}{90.0 \text{ g H}_2\text{O}} \times \frac{1 \text{ mol NH}_3}{17.03 \text{ g NH}_3} = 0.587 \text{ mol/L}
      \]
   b. (4 points) Calculate the molarity of NH₃ in the solution.
      \[
      \text{molarity} = \frac{\text{mol solute}}{\text{L solution}} = \frac{0.587 \text{ mol NH}_3}{0.0982 \text{ L}} = 5.97 \text{ mol/L}
      \]

4. (4 points) The boiling point of benzene, C₆H₆, is 80.100 °C at 1 atmosphere. Kₐ(benzene) = 2.53°C/m. In a laboratory experiment, students synthesized a new compound and found that when 14.28 grams of the compound were dissolved in 261.2 grams of benzene, the solution began to boil at 80.682 °C. The compound was also found to be nonvolatile and a non-electrolyte. What is the molecular weight they determined for this compound?
   \[
   \Delta T_b = 80.682 - 80.100 = 0.582 ^\circ C
   \]
   \[
   m = \frac{\Delta T_b}{K_a} = \frac{0.582}{2.53} = 0.230 \text{ mol/kg}
   \]
   \[
   (0.230 \text{ mol/kg})(261.2 \text{ kg}) = 0.0601 \text{ mol}
   \]
   \[
   \frac{14.285}{0.0601 \text{ mol}} = 238 \text{ g/mol}
   \]
5. (4 points) An aqueous solution is 0.10 molal in sodium sulfate, $\text{Na}_2\text{SO}_4$.

a. What ions, atoms and molecules are present in the solution and what are the concentrations of each? (Fill in the appropriate number of blanks below.)

i. Ion, atom or molecule $\text{Na}^+$ concentration 0.20
ii. Ion, atom or molecule $\text{SO}_4^{2-}$ concentration 0.10
iii. Ion, atom or molecule ___________________________ concentration
iv. Ion, atom or molecule ___________________________ concentration
v. Ion, atom or molecule ___________________________ concentration

b. What is the freezing point of this solution? ($K_f(\text{H}_2\text{O}) = -1.86 \, ^\circ\text{C/m}$, $\Delta T_f = i K_f m$). Show your work.

$$\Delta T_f = i K_f m = (3)(-1.86)(0.10) = -0.56 \, ^\circ\text{C}$$

$$T_f = -0.56 \, ^\circ\text{C}$$