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Workshop #13: Colligative Properties

Show calculation setups and answers for all problems below.

1. List the following aqueous solutions in the order of expected DECREASING FREEZING POINT: 0.075 *m* glucose; 0.075 *m* LiBr; 0.030 *m* $Zn(NO_3)_2$.

2. The normal freezing point of pure naphthalene is measured to be 80.29 °C. When 32.21 g of the nonelectrolyte urea (CH_4N_2O) is dissolved in 751.36 g of naphthalene, the freezing point is measured to be 75.34 °C. What is the molal freezing point depression constant (K_f) for naphthalene?

3. When 132.0 g of C_6H_6 (P° = 93.96 torr) and 147.0 g of $C_2H_4Cl_2$ (P° = 224.9 torr) are combined, what is the total vapor pressure of the ideal solution?

4. Calculate the freezing point of a solution of 22.0 g of carbon tetrachloride dissolved in 800.0 g of benzene (K_f = 5.12 °C / *m*; normal freezing point = 5.5 °C).

5. What mass of $NiSO_4 \cdot 6H_2O$ must be dissolved in 500. g of water to produce 0.33 *m* $NiSO_4$(aq)?

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6. What is the normal boiling point of an aqueous solution that has a freezing point of –1.04 °C?

   Note: For water, K_f = 1.86 °C/*m*; K_b = 0.512 °C/*m*

7. Assuming complete dissociation, calculate the freezing point of a 0.100 *m* aqueous solution of K_2SO_4 (ignore any interionic attractions).

   Note: For water, K_f = 1.86 °C/*m*

8. When 2.25 g of an unknown nonelectrolyte was dissolved in 150. g of cyclohexane, the boiling point increased by 0.481 K. Determine the molar mass of the compound.

   Note: K_b (cyclohexane) = 2.79 K/*m*

9. A 0.50 g sample of *immunoglobulin G*, a nonvolatile nonelectrolyte, is dissolved in enough water to make 0.100 L of solution, and the osmotic pressure of the solution at 25 °C is found to be 0.619 torr. Calculate the molecular mass of *immunoglobulin G*.

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10. When 2.74 g of phosphorus is dissolved in 100.0 mL of carbon disulfide, the boiling point is 319.71 K. Given that the normal boiling point of pure carbon disulfide is 319.30 K, its density is 1.261 g / mL, and its boiling-point elevation constant is K_b = 2.34 K / *m*, determine the molar mass of phosphorus.

11. A solution of biphenyl ($C_{12}H_{10}$), a nonvolatile nonelectrolyte, in benzene has a freezing point of 5.4 °C. Determine the osmotic pressure of the solution at 10 °C if its density is 0.88 g / cm^3.

    Note: normal freezing point (benzene) = 5.5 °C; K_f = 5.12 °C/*m*

12. Consider these two solutions: Solution A is prepared by dissolving 5.00 g of $MgCl_2$ in enough water to make 0.250 L of solution, and Solution B is prepared by dissolving 5.00 g of KCl in enough water to make 0.250 L of solution. Which direction will solvent ***initially*** flow if these two solutions are separated by a semipermeable membrane?

13. Assuming that the volumes of the solutions described in question #12 are additive and ignoring any effects that gravity may have on the osmotic pressure of the solutions, what will be the ***final*** volume of solution A when the net solvent flow through the semipermeable membrane stops?