CHEM 1105

Colligative Properties

Problems from Silberberg's Chemistry, 2nd edition

1. An 8.00 % (by mass) solution of aqueous ammonia has a density of 0.9651g/mL. Calculate the molarity, the molality, and the mole fraction of ammonia in this solution. **(4.53 M; 5.11 *m*; 0.0842)**

2. A florist prepares a solution of nitrogen-phosphorus fertilizer by dissolving 5.66 g NH_4NO_3 and 4.42 g $(NH_4)_3PO_4$ in enough water to make a 20.0 L solution. What are the molar concentrations of ammonium ion and phosphate ion in this solution? **(7.98×10^{-3} M NH_4^+; 1.48×10^{-3} M PO_4^{3-})**

3. Classify each of the following aqueous solutions as strong electrolytes, weak electrolytes or non-electrolytes.

Substance	**Classification**	**Substance**	**Classification**
HCl (aq)		C_5H_5N (aq)	
KNO_3 (aq)		$C_3H_8O_3$ (aq)	
$C_6H_{12}O_6$ (aq)		H_3PO_4 (aq)	
NH_3 (aq)		$AlCl_3$ (aq)	

4. When making ice cream, the temperature of the ingredients is kept below 0 ºC by using a salt - ice bath. What mass of NaCl is needed to lower the melting point of 5.5 kg ice to -5.0 ºC? (Assume that all of the salt will dissolve to form a solution). What mass of $CaCl_2$ would be needed to have the same effect? **(4.3×10^2 g NaCl; 5.5×10^2 g $CaCl_2$)**

5. What is the freezing point of 0.111 *m* urea in water? (K_f of water is 1.86 ºC/*m*) **(–0.206 ºC)**

6. The boiling point of ethanol (C_2H_6O) is 78.5 ºC. What is the boiling point of a solution of 3.40 g of vanillin ($\mathcal{M}$ = 152.14 g) in 50.0 g ethanol? (K_b of ethanol is 1.22 ºC/*m*) **(79.0 ºC)**

7. The freezing point of benzene is 5.5 ºC. What is the freezing point of a solution of 5.00 g naphthalene ($C_{10}H_8$) in 444 g benzene? (K_f of benzene is 4.90 ºC/*m*) **(5.1 ºC)**

8. What is the minimum mass of ethylene glycol ($C_2H_6O_2$) that must be dissolved in 14.5 kg water to prevent the solution from freezing at –10.0 ºC? **(4840 g)**

9. A solution is prepared by dissolving 1.50 g of a compound in 25.0 mL water at 25 ºC. The boiling point of the solution is 100.45 ºC. What is the molar mass of the compound? (density of water at 25 ºC is 0.997 g/mL; K_b of water is 0.512 ºC/*m*) **(1 mol = 68.5 g)**

10. Which of the following solutions has the lower freezing point: 10.0 g CH_3OH in 100. g H_2O, or 20.0 g CH_3CH_2OH in 200. g H_2O? Prove your choice with an appropriate calculation. **(CH_3OH (aq))**

11. Rank the following aqueous solutions in order of a) increasing boiling point, and b) increasing freezing point. 0.100 *m* $NaNO_3$; 0.200 *m* glucose and 0.100 *m* $CaCl_2$. **($CaCl_2$ sol'n has the lowest fp and highest bp; $NaNO_3$ and glucose will have less effect)**