CHEMISTRY 116 - Fall 2021

Dr. Audrey Dell Hammerich

Discussion Worksheet - Week 9

1. When are the molarity and molality of a solution approximately equal?

2. What is the density of a 9.9 M, 50.0 mass percent solution of ethanol (C_2H_5OH, $M = 46.07$ g/mol) in water? [0.91 g mL^{-1}]

3. An aqueous solution contains equal amounts of water ($M = 18.01$) and nitric acid ($M = 63.01$) by mass.
   a) What is the mole fraction of HNO_3 in the solution? [0.2223]

   b) What is the molality of HNO_3 in the solution? [15.87 m]

4. Commercial concentrated hydrochloric acid ($M = 36.46$) is 38.00 percent HCl by mass with a solution density of 1.1886 g cm^{-3} at 20°C. What is
   a) the mole fraction of HCl? [0.2324]

   b) the molality of HCl? [16.81 m]

   c) the molarity of HCl? [12.39 M]

5. Tell how adding a nonvolatile solute to a volatile solvent effects the a) vapor pressure of the solution, b) freezing point of the solution, and c) boiling point of the solution.

6. 25.0 g of an unknown molecular solid are dissolved in 275 g of water at a temperature at which the vapor pressure of water is 72.0 mm Hg. Determine the molar mass of the solid if the vapor pressure of the solution is 71.0 mm Hg at the same temperature. [120 g mol^{-1}]

7. The vapor pressure of water at 90°C is 525.8 mm Hg. What mass of ethylene glycol ($C_2H_6O_2$) must be dissolved in 1.50 kg of water at 90°C to reduce the vapor pressure above the solution to 467 mm Hg?

8. At 35°C the vapor pressure of acetone is 347 mm Hg and that of chloroform is 293 mm Hg. An ideal solution (obeys Raoult's law) is made from 5.80 g acetone ($M = 58.079$) and 11.9 g chloroform ($M = 119.378$).

a) What is the mole fraction composition of the solution? [$\chi_a = 0.500$]

b) What is the total vapor pressure of the solution? [320 mm Hg]

c) What is the mole fraction composition of the vapor? [$\chi_a = 0.543$]

9. 50.0 g of an unknown molecular solid dissolved in 200.0 g of water gives a solution that freezes at -0.230°C. Calculate the molar mass of the solid. (for water $K_f = 1.86$ K kg mol^{-1}) [2020 g mol^{-1}]

10. When 1.744 g of a nonvolatile solute whose molar mass is unknown is dissolved in 122.2 g of acetic acid, the boiling point of the acid is elevated by 0.246°C. In another experiment 0.0100 mol of a different nonvolatile solute elevates the boiling point of 1.00 kg of acetic acid by 0.030°C. Determine the molar mass of the first solute.
[178 g/mol]

11. 30.0 g of NaCl are dissolved in 600 g of water. Assuming total dissociation, determine the boiling point of the solution. (for water $K_b = 0.512$ K kg mol^{-1}) [100.876°C]

12. An aqueous 0.0911 *m* solution of $K_3Fe(CN)_6$ freezes at -0.676°C. (for water $K_f = 1.86$ K kg mol^{-1})

a) What freezing point would be expected if the compound did not dissociate into ions? [-0.169°C]

b) What is the apparent number of ions that $K_3Fe(CN)_6$ dissociates into? [4]

13. 200 mg of the protein cytochrome *c* (whose molar mass is 12,400 g mol^{-1}) are dissolved in 10 cm^3 of water at room temperature. At 25°C the vapor pressure of water is 23.756 mm Hg. Determine the change in the a) vapor pressure, b) freezing point, and c) boiling point of the solution compared with that of pure water and determine the osmotic pressure of the protein solution and comment. (for water $K_f = 1.86$ K kg mol^{-1}, $K_b = 0.512$ K kg mol^{-1})
[-0.00069 mm Hg, -0.0030°C, 0.00082°C, 0.039 atm]

14. a) What is the ionic strength of 0.1 M NaCl? [0.1 M]

b) What is the ionic strength of 0.1 M $MgSO_4$ assuming complete dissociation into ions? [0.4 M]