Exercises sheet on solutions

(1) Predict whether each of the following solvents is miscible or immiscible with water:

(a) Methanol, CH_3OH (b) Toluene, C_7H8

(c) Methylene chloride, CH_2C_{l2} (d) Glycerin, $C_3H_5(OH)_3$

(2) Predict whether each of the following solid compounds is soluble or insoluble in water:

(a) Fructose, $C_6H_{12}O_6$ (b) lithium carbonate, Li_2CO_3

(c) Naphthalene, $C_{10}H_8$ (d) Anthracene, $C_{14}H_{10}$

(e) Cupric sulfate, $CuSO_4$ (f) lactic acid, $C_3H_6O_3$

(3) At 20 °C, the concentration of dissolved oxygen in water exposed to gaseous oxygen at a partial pressure of 101.3 kPa (760 torr) is 1.38×10^{-3} mol L^{-1}. Use Henry's law to determine the solubility of oxygen when its partial pressure is 20.7 kPa (155 torr), the approximate pressure of oxygen in earth's atmosphere.

(4) A solution contains 5.0 g of urea, $CO(NH_2)_2$ (a non-volatile solute) and 0.1 kg of water. If the vapor pressure of pure water at 25 °C is 23.7 torr, what is the vapor pressure of the solution?

(5) Exposing a 100.0 mL sample of water at 0 °C to an atmosphere containing a gaseous solute at 20.26 kPa (152 torr) resulted in the dissolution of 1.45×10^{-3} g of the solute. Use Henry's law to determine the solubility of this gaseous solute when its pressure is 101.3 kPa (760 torr).

(6) Styrene (C_8H_8) and ethylbenzene (C_8H_{10}) form an ideal mixture upon mixing. If a mixture is composed of 38% styrene and 62% ethylbenzene, by mass, at 90 ^oC, what is the composition of the vapor in equilibrium with the liquid mixture? The vapor pressure of styrene and ethylbenzene at 90 ^oC are 134 mmHg and 182 mmHg, respectively.

(7) Sucrose ($C_{22}O_{11}H_{22}$), like many sugars, is highly soluble in water; almost 2000 g will dissolve in 1 L of water, giving rise to what amounts to pancake syrup. Estimate the boiling point of such a sugar solution.

(8) Estimate the freezing point of an antifreeze mixture that is made up by combining one volume of ethylene glycol (MW = 62, density 1.11 g cm^{-3}) with two volumes of water (density = 0.997 g cm^{-3}.

(9) What is the freezing point of a 1.85 *m* solution of a nonvolatile non-electrolyte solute in diethyl ether?

(10) What is the boiling point of a solution of 1.0 g of glycerin, $C_3H_5(OH)_3$, in 47.8 g of water? Assume an ideal solution.

(11) An aqueous solution of nitrous acid (HNO_2, MW = 47) freezes at (- 0.198 ^oC). If the solution was prepared by adding 0.1 mole of the acid to 1 kg of water, what percentage of the HNO_2 is dissociated in the solution?

(12) The antifreeze in most automobile radiators is a mixture of equal volumes of ethylene glycol, $C_2H_4(OH)_2$, and water, with minor amounts of other additives that prevent corrosion. What are the (a) mole fraction and (b) molality of ethylene glycol, and (c) the boiling point of the antifreeze solution prepared from approximately 2 L of glycol and 2 L of water?

(13) The vapor pressure of pure water is 23.8 mmHg at 25 °C. What is the vapor pressure of 2.5 molal $C_6H_{12}O_6$?

(14) A nonvolatile organic compound Z was used to make up a solution. Solution A contains 5.00 g of Z dissolved in 100. g of water and has a vapor pressure of 754.5 mmHg at the normal boiling point of water. Calculate the molar mass of Z.

(15) The concentration of ions in seawater is approximately the same as that in a solution containing 4.2 g of NaCl dissolved in 125 g of water. Assume that each of the ions in the NaCl solution has the same effect on the freezing point of water as a non-electrolyte molecule, and determine the freezing temperature the solution (which is approximately equal to the freezing temperature of seawater).

(16) Assume that each of the ions in calcium chloride, $CaCl_2$, has the same effect on the freezing point of water as a non-electrolyte molecule. Calculate the freezing point of a solution of 0.724 g of $CaCl_2$ in 175 g of water.

(17) Determine the osmotic pressure of a solution made by adding 13.65g of sucrose($C_{12}H_{22}O_{11}$) in water to make 250 mL of solution at 25^{o}C.

(18) How much glucose ($C_6H_{12}O_6$) per liter should be used for an intravenous solution to match the 7.65 atm at 37 °C osmotic pressure of blood?

(19) Determine the osmotic pressure of the aqueous solution which contains 14g of urea, $CO(NH_2)_2$, in 300cm^3 of the solution at 25^{0}C.