Assignment 13 A

1- When an ionic salt dissolves in water, the solute-solvent interaction is

a) dipole-dipole.
b) hydrogen bonding.
c) ion-ion forces.
d) London dispersion.
e) ion-dipole.

(This represents the attraction between the ion and the polar water molecule.)

2- The solubility of $Cr(NO_3)_3 \cdot 9H_2O$ in water at 15°C is 208 g per 100. mL of solution. Is a 1.22 *M* solution of $Cr(NO_3)_3 \cdot 9H_2O$ in water at 15°C saturated, supersaturated, or unsaturated?

a) unsaturated
b) supersaturated
c) saturated

(1.22 M is less than 5.20 M, the solubility of $Cr(NO_3)_3 \cdot 9H_2O$ in water in units of molarity.)

3- Consider the solubilities of the following organic compounds in water. Which ranking of *decreasing* solubility is probably correct (the most soluble first, etc.)?

1) CH_3CH_2OH
2) $CH_3(CH_2)_4CH_3$
3) $CH_3(CH_2)_5CH_2OH$
4) $CH_3(CH_2)_4CH_2OH$

a) 3 > 1 > 4 > 2
b) 1 > 3 > 4 > 2
c) 1 > 3 > 2 > 4
d) 3 > 4 > 1 > 2
e) 1 > 4 > 3 > 2

(The larger the nonpolar chain, the less soluble the alcohol. Also,the nonpolar hydrocarbon should be least soluble.)

4- The Henry's law constant for CO_2 gas in water at 25°C is 3.1×10^{-2} *M*/atm; that for N_2 at 25°C is 6.8×10^{-4} *M*/atm. If the two gases are each present at 5.0 atm pressure, calculate the solubility of each gas.

a) 3.2×10^{-1} *M* CO_2; 6.8×10^{-3} *M* N_2
b) 6.2×10^{-3} *M* CO_2; 1.4×10^{-4} *M* N_2
c) 3.1×10^{-3} *M* CO_2; 6.8×10^{-5} *M* N_2
d) 1.6×10^{-1} *M* CO_2; 3.4×10^{-3} *M* N_2
e) 1.6×10^{2} *M* CO_2; 7.4×10^{3} *M* N_2

(You multiplied the pressure of each gas by the Henry's law constant.)

5- What is the molality of a solution prepared by mixing 25.0 g ethylene glycol (molar mass = 62.1; CH_2OHCH_2OH) with 125 g of water?

a) 200. *m*
b) 3.13 *m*
c) 20.0 *m*
d) 2.68 *m*
e) 3.22 *m*

(The molality is equal to the number of moles of solute divided by the solvent mass in kilograms.)

6- At 63.5°C the vapor pressure of H_2O is 175 torr, and that of ethanol, C_2H_5OH, is 400. torr. A solution is made by mixing equal masses of H_2O and C_2H_5OH. What is the mole fraction of ethanol in the solution, and assuming ideal-solution behavior, what is the vapor pressure of the solution at 63.5°C?

a) $X_{ethanol} = 0.281$, $P = 238$ torr
b) $X_{ethanol} = 0.719$, $P = 337$ torr
c) $X_{ethanol} = 0.500$, $P = 200$ torr
d) $X_{ethanol} = 0.500$, $P = 188$ torr
e) $X_{ethanol} = 0.719$, $P = 288$ torr
f) $X_{ethanol} = 0.281$, $P = 112$ torr

(The total pressure is the sum of the vapor pressure of each component as calculated by Raoult's law.)

7- Calculate the freezing points of 0.17 *m* glycerol in ethanol, for which the freezing point depression constant is 1.99 °C/m and the freezing point is −114.6 °C and for 1.92 mol of naphthalene, $C_{10}H_8$, in 16.8 mol of chloroform, $CHCl_3$, for which the freezing point depression constant is 4.68 °C/*m* and the freezing point is −63.5 °C.

a) −114.3°C and −63.5°C
b) −114.3°C and −59.0°C
c) −114.3°C and −64.0°C
d) −114.9°C and −64.0°C
e) −114.9°C and −68.0°C

(The freezing point decreases by an amount equal to the molality times the freezing-point depression constant.)

8- What is the osmotic pressure in atm produced by a 1.20 *M* glucose ($C_6H_{12}O_6$) solution at 25°C?

a) 29.3 atm
b) 26.9 atm
c) 0.163 atm
d) 2.46 atm
e) 20.4 atm

(You used the equation $\pi = MRT$ *to calculate the osmotic pressure.*

9- Indicate whether each of the following is a hydrophilic or a hydrophobic colloid: **(i)** butterfat in homogenized milk **(ii)** hemoglobin in blood **(iii)** vegetable oil in an oil and vinegar salad dressing

a) (i) hydrophilic (ii) hydrophobic (iii) hydrophilic
b) (i) hydrophilic (ii) hydrophobic (iii) hydrophobic
c) (i) hydrophobic (ii) hydrophobic (iii) hydrophobic
d) (i) hydrophobic (ii) hydrophilic (iii) hydrophobic
e) (i) hydrophilic (ii) hydrophilic (iii) hydrophilic

(Hydrophilic colloids mix well with water, while hydrophobic colloids do not mix well with water.)

10- Which one of the following is *incorrect?*

a) Emulsifiers have the ability to keep substances in suspension as a colloid.
b) Hydrophobic colloids like to be associated with water.
c) The diameter of colloidal particles is usually in the range 5 - 1000 nm.
d) Coagulation is often induced by heating.
e) Colloids will not pass through semi-permeable membranes.

(Hydrophilic colloids like water; hydrophobic colloids do not.)

11- Which of the following statements is *incorrect*?

a) Gases always are less soluble in water as the temperature increases.
b) The more hydroxyl (OH) groups on an alcohol, the more soluble it is in water.
c) The solubility of alcohols in water increases as the number of carbons atoms in the alcohol increases.
d) As lakes heat up, less oxygen can dissolve. This adversely affects fish.
e) Solids usually, but not always, increase their water solubility as the temperature increases.

(The opposite is true; shorter chain alcohols are more soluble in water.)

12- 25.0 g of KBr is dissolved in enough water to produce 456 mL of the solution. What is the molarity of this solution?

a) 4.61×10^{-4} *M*
b) 0.921 *M*
c) 54.8 *M*
d) 0.461 *M*
e) 0.210 *M*

(There are 0.210 mol of KBr in 0.456 L of solution.)

13- The density of acetonitrile, CH_3CN, is 0.786 g/mL, and the density of methanol, CH_3OH, is 0.791 g/mL. A solution is made by dissolving 15.0 g of methanol in 250.0 mL of acetonitrile. Assuming that the volumes of the solute and solvent are additive, what is the molarity of methanol in the solution?

a) 1.87×10^{-3} *M*
b) 1.87 *M*
c) 24.7 *M*
d) 1.74 *M*
e) 1.74×10^{-3} *M*

(The moles of the CH_3OH divided by the liters of solution equals the molarity of methanol in the solution.)

14- A 5.25% by mass aqueous solution of NaI can be prepared by dissolving

a) 5.25 g NaI in 100 g water.
b) 5.25 mol NaI in 1.00 L solution
c) 5.25 mol NaI in 1.00 kg water.
d) 5.25 g NaI in 94.75 mL water.
e) 1.00 g NaI in 5.25 g water.

(5.25 mass percent is equivalent to 5.25 g out of a total 100 g, meaning that the mass of the water would be 94.75 g; assuming the density of water is 1.000 g/mL, 94.75 g of water is equivalent to 94.75 mL of water.)

15- The vapor pressure of pure water at 22°C is 19.8 torr. The vapor pressure of water over a solution at 22°C containing equal numbers of moles of water and an unknown nondissociating solute is 9.9 torr. What is the mole fraction of water, and is the solution ideal in terms of Raoult's law?

a) 0.50 and non-ideal
b) 1.0 and ideal
c) 1.0 and non-ideal
d) 0.50 and ideal

(The vapor pressure predicted by Raoult's law is 9.9 torr.)

16- What is the freezing point of a 0.15 *m* organic compound solution in benzene? The freezing point depression constant for benzene is 5.12 °C/*m*. The normal freezing point for benzene is 5.5 °C.

a) 4.7°C
b) 0.77°C
c) 6.3°C
d) 0.38°C
e) −0.77°C

(The freezing point is decreased by an amount equal to the molality times the freezing-point depression constant.)

17- Three beakers are placed in a sealable container. Beaker A is filled with 100 mL of pure water, beaker B is filled with 100 mL of 1 m aqueous salt solution, and beaker C is filled with 100 mL of 1.00 m aqueous sugar solution. The container is sealed for several days and then reopened to the discovery that the three

beakers no longer contain equal volumes. What would you predict to be the relationship of the volumes in beakers A, B, and C?

a) $V_A = V_B > V_C$
b) $V_C > V_B > V_A$
c) $V_B > V_C > V_A$
d) $V_B = V_C > V_A$
e) $V_A > V_B > V_C$

(The water will transfer via the vapor phase from the pure water to the solutions, with more going to the solution that has the highest solute molality and lowest concentration of water. Keep in mind that a salt dissociates into ions, increasing the number of solution particles. Therefore, the salt solution will take on more of the water than the sugar solution.)

18- A solution is prepared by dissolving 6.00 g of an unknown nonelectrolyte in enough water to make 1.00 L of solution. The osmotic pressure of this solution is 0.750 atm at 25.0°C. What is the molar mass of the unknown solute (R = 0.0821 L·atm/K·mol)?

a) 179 g/mol
b) 5.11 g/mol
c) 196 g/mol
d) 110. g/mol
e) 16.4 g/mol

(The molar mass is the number of grams divided by the number of moles calculated from the osmotic pressure.)

19- List the following aqueous solutions in order of increasing boiling point: 0.035 *m* glycerin; 0.020 *m* KBr; 0.030 *m* phenol, C_6H_5OH.

a) 0.030 *m* phenol < 0.035 *m* glycerin < 0.020 *m* KBr
b) 0.020 *m* KBr < 0.035 *m* glycerin < 0.030 *m* phenol
c) 0.020 *m* KBr < 0.030 m phenol < 0.035 *m* glycerin
d) 0.035 *m* glycerin < 0.030 *m* phenol < 0.020 *m* KBr
e) 0.035 *m* glycerin < 0.020 *m* KBr < 0.030 *m* phenol

(This is the order of increasing total molality, accounting for the fact that the KBr dissociates100 percent in water solution.)

20- What is the freezing point (in °C) of a solution prepared by dissolving 11.3 g of $Ca(NO_3)_2$ (formula weight = 164 g/mol) in 115 g of water? The molal freezing-point depression constant for water is 1.86°C/*m*.

a) −3.34°C
b) 3.34°C
c) −1.11°C
d) 1.11°C
e) −2.22°C

($Ca(NO_3)_2$ ionizes to give three moles of ions per mole of solute.)

21- Lysozyme is an enzyme that breaks bacterial cell walls. A solution containing 0.150 g of this enzyme in 210 mL of solution has an osmotic pressure of 0.953 torr at 25°C. What is the molar mass of this substance?

a) 1.17×10^3 g/mol
b) 13.9 g/mol
c) 18.3 g/mol
d) 1.41×10^6 g/mol
e) 1.39×10^4 g/mol

(You calculated the molarity, the number of moles of lysozyme, and then its molar mass.)

22- A solution is prepared by dissolving 23.7 g of $CaCl_2$ in 375 g of water. The density of the resulting solution is 1.05 g/mL. Calculate the molarity of Cl^- in the solution described above.

a) 1.12 *M*
b) 0.562 *M*
c) 0.598 *M*
d) 1.07 *M*
e) 0.214 *M*

(This is the desired molarity recognizing that 2 moles of Cl^- are present in solution for each mole of $CaCl_2$ dissolved.)

23- What volume of dilute hydrochloric acid (10.8 percent by mass HCl) contains 60.0 g of water (density = 1.05 g/mL)?

a) 64.1 mL
b) 70.6 mL
c) 67.3 mL
d) 51.0 mL
e) 56.2 mL

(60.0 g of water is 89.2 percent of the mass. You can find the mass of 100 percent of the solution from this value. Then use the density to find the volume of this mass of solution)

24- Which of these aqueous solutions would have the *lowest* freezing point?

a) 1.0 *m* lithium sulfate
b) 1.0 *m* hydrochloric acid
c) 1.0 *m* glucose sugar
d) 1.0 *m* cesium iodide
e) 1.0 *m* magnesium sulfate

(The solution with the lowest freezing point corresponds to the one with the highest concentration of particles in solution. Lithium sulfate separates into three ions in solution per lithium sulfate formula unit.)

25- What is the concentration of CO_2 in ppm of 0.042 g of CO_2 in 120. g of nitrogen, N_2, and 30.0 g of oxygen, O_2, all present in a gas?

a) 28 ppm
b) 350 ppm
c) 280 ppm
d) 0.028 ppm
e) 4.2 ppm

(The concentration in ppm is the mass fraction times 10^6.)