Review questions/problems for Solutions Unit Chapter 12 and 13

Chapter 12

p.406 SR 1&5; p. 416 SR 3-7; p. 424 PP 1&2; p. 424 SR 1-4; p. 427 (20, 21, 24, 27-29)

Chapter 13

p. 443 SR 1-4; p. 450 PP 3&4; p. 451 PP 1-4; p. 455 PP 1-3; p. 456 SR 2&3

Identify the precipitate formed when 200 ml of 0.50 M solution of calcium chloride is combined with a silver nitrate solution. Write the net ionic equation, identify the spectator ions and calculate the mass of ppt. formed.

Bonus challenge question:

What volume of 15M HNO_3 should be added to 1250 ml of 2M HNO_3 to prepare 14 liters of 1 M HNO_3? (water is added to make the final volume exactly 14 liters).

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Answer Key

Chapter 12

p.406 SR 1&5

1. Classify the following as either a heterogeneous or homogenous mixture, and explain your answers. A. orange juice: *heterogeneous; the pulp and aqueous components together constitute a suspension.* B. tap water: *homogeneous; the water and solutes together constitute a solution.*
5. Name the solute and solvent in the following: A. 14- karat gold *Solvent: gold. Solute: Silver, Copper* B. corn syrup *Solvent: water. Solute: sugar* C. Carbonated, or sparkling, water *Solvent: water. Solute: Carbon Dioxide*

p. 416 SR 3-7

3. Explain why ethanol will dissolve in water and carbon tetrachloride will not. *Ethanol and water are each polar molecules. The negatively charged region of the ethanol molecules is attracted to the positively charged region of the water molecules, and vice versa. Carbon tetrachloride is nonpolar and will not form a strong enough attraction to water molecules to dissolve*
4. When a solute molecule is solvated, is energy released or absorbed? *Intermolecular attraction brings the solvent and solute molecules together. Energy is released in this process.*
5. If a warm bottle of soda and a cold bottle of soda are opened, which will effervesce more and why? *The warm bottle will effervesce more because the gas will be less soluble in the warmer bottle of soda.*
6. You get a small amount of lubricating oil on your clothing. Which would work better to remove the oil – water or toluene? Explain your answer. *Toluene; because oil and toluene are nonpolar, they will dissolve in each other*
7. A commercial "fizz saver" pumps helium under pressure into a soda bottle to keep gas from escaping. Will this keep CO_2 in the soda bottle? Explain your answer *It will not keep CO_2 from escaping from solution; Henry's law states that it is the partial pressure of the same gas above the solution that is in the solution that keeps that gas in solution. Increased pressure of only helium will have no effect on CO_2's solubility.*

p. 424 PP 1&2

1. What is the molality of acetone in a solution composed of 255 g of acetone, $(CH_3)_2$, CO, dissolved in 200.g of water? *molality = moles of solute/kg solvent; 255 g x 1 mole/58 g x 1/0.200 kg =* ***21.98 m***
2. What quantity, in grams, of methanol, CH_3OH, is required to prepare a 0.244 m solution in 400 g of water? *m = moles of solute/kg solvent; 0.244 m x 0.400 kg = 0.0976 moles x 32 g/mole =* ***3.12 g CH_3OH***

p. 424 SR 1-4

1. What quantity represents the ratio of the number of moles of solute for a given volume of solution? *Molarity*
2. We dissolve 5.00 grams of sugar, $C_{12}H_{22}O_{11}$, in water to make 1.000 L of solution. What is the concentration of this solution expressed as a molarity? *5.00 g x 1 mole/342 g x 1/1.0 l =* ***0. 0146 M****.*
3. You evaporate all of the water from 100. mL of NaCl solution and obtain 11.3 grams of NaCl. What is the molarity of the NaCl solution? *11.3 g NaCl x 1mole/58 g x 1/0.1 l =* ***1. 93 M NaCl***
4. Suppose you know the molarity of a solution. What additional information would you need to calculate the molality of the solution? ***The density of the solution****.*

p. 427 (20, 21, 24) p. 427 (27-29)

20. a. Suppose you wanted to produce 1.00 L of a 3.50 M aqueous solution of H_2SO_4.
(1) What is the solute? **H_2SO_4**
(2) What is the solvent? **water**
(3) How many grams of solute are needed to make this solution?
3.50 m x 98 g/mol = 343 g H_2SO_4
b. How many grams of solute are needed to make 2.50 L of a 1.75 M solution of $Ba(NO_3)_2$?
M = mol/L → mol = M x L → 1.75 M x 2.50 L = 4.38 mol x 261 g/mol = 1.14×10^3 g $Ba(NO_3)_2$

21. How many moles of NaOH are contained in 65.0 ml of a 2.20 M solution of NaOH in H_2O? (Hint: see sample problem B)
M = mol/L → mol = M x L → 2.20 M x 0.065 L = 0.143 mol NaOH
24. a. Balance the equation: **2**H_3PO_4 + **3**$Ca(OH)_2$ → $Ca_3(PO_4)_2$ + **6**H_2O
b. What mass of each product results if 750 mL of 6.00 M H_3PO_4 reacts according to the equation?
M = mol/L → mol = M x L → 6.00 M x 0.75 L = 4.5 mol H_3PO_4

4.5 mol H_3PO_4 x 1 mol $Ca_3(PO_4)_2$ / 2 mol H_3PO_4 x 310 g $Ca_3(PO_4)_2$ / 1 mol $Ca_3(PO_4)_2$ = 697.5 g $Ca_3(PO_4)_2$

4.5 mol H_3PO_4 x 6 mol H_2O / 2 mol H_3PO_4 x 18 g H_2O / 1 mol H_2O = 243 g H_2O

27. Determine the number of grams of solute needed to make each of the following molal solutions:
a. a 4.50 *m* solution of H_2SO_4 in 1.00 kg H_2O
***m* = mol solute/kg solvent → mol = *m* x kg solvent**
4.50 *m* x 1 kg = 4.50 mol H_2SO_4 x 98 g/mol = 441 g H_2SO_4

b. a 1.00 *m* solution of HNO_3 in 2.00 kg H_2O
***m* = mol solute/kg solvent → mol = *m* x kg solvent**
1.00 *m* x 2.00 kg = 2.00 mol x 63 g/mol = 126 g HNO_3

28. A solution is prepared by dissolving 17.1 g of sucrose, $C_{12}H_{22}O_{11}$, in 275 g of H_2O.
a. What is the molar mass of sucrose? **342 g/mol**
b. What is the molality of that solution?
17.1 g ÷ 342 g/mol = 0.05 mol ÷ 0.275 kg = 0.18 *m*

29. How many kilograms of H_2O must be added to 75.5 g of $Ca(NO_3)_2$ to form a 0.500 *m* solution?
75.5 g $Ca(NO_3)_2$ ÷ 164 g/mol = 0.46 mol $Ca(NO_3)_2$
***m* = mol solute/kg solvent**
kg solvent = mol solute/m → 0.46 mol ÷ 0.500 *m* = 0.920 kg H_2O

Chapter 13
p. 443 SR 1-4

1. Write the equation for the dissolution of $Sr(NO_3)_2$ in water. How many moles of strontium ions and nitrate ions are produced by dissolving 0.5 mol of strontium nitrate?
$Sr(NO_3)_2$ (s) → Sr^{2+} (aq) + $2NO_3^-$; ***0.5 mol Sr^{2+} and 1.0 mol NO_3^-***
2. Will a precipitate form if solutions of magnesium acetate and strontium chloride are combined?
No*. The salts that could potentially form, magnesium chloride and strontium acetate, are soluble.*
3. What determines whether a molecular compound will be ionized in a polar solvent? *If the attraction of polar solvent molecules is stronger than a covalent bond in the solute, the molecule will break into ions.*

4. Explain why HCl is a strong electrolyte and HF is a weak electrolyte. *HCl is essentially 100% ionized in water solution, whereas HF is only slightly ionized because its H—F covalent bond is strong.*

p. 450 PP 3&4

3. If .500 mol of a nonelectrolyte solute are dissolved in 500.0 g of ether, what is the freezing point of the solution? $\Delta T_f = K_f m$; *(-1.79 °C/m)(0.500 mol/0.500 kg)* **= -1.79 so -116.3 – 1.79 = -118.1°C**

4. The freezing point of an aqueous solution that contains a nonelectrolyte is -9.0°C. a. What is the freezing-point depression of the solution? $\Delta T_f = K_f m$; *-9.0°C*

B. What is the molal concentration of the solution? *-9.0 °C = (-1.86 °C/m)(x) → x =* **4.8 molal**

p. 451 PP 1-4

1. A solution contains 50.0 g of sucrose, $C_{12}H_{22}O_{11}$, a nonelectrolyte, dissolved in 500.0g of water. What is the boiling-point elevation? $\Delta T_b = K_b m$ *(0.51 °C/m)(50.0g/342g/mole÷0.500 kg)* **= 0.15°C**

2. A solution contains 450.0 g of sucrose, $C_{12}H_{22}O_{11}$ a non electrolyte, dissolved in 250.0 g of water. What is the boiling point of the solution? $\Delta T_b = K_b m$ *(0.51 °C/m)(450.0 g/342g/mole ÷ 0.250 kg)= 2.68° + 100 =* **102.7°C**

3. If the boiling-point elevation of an aqueous solution containing a nonvolatile electrolyte is 1.02°C, what is the molality of the solution? $\Delta T_b = K_b m$ *1.02 °C = (0.51 °C/m) (x) → x =* **2.0 m**

4. The boiling point of an aqueous solution containing a nonvolatile electrolyte is 100.75°C. a. What is the boiling-point elevation? $\Delta T_b = K_b m$ **0.75°C**

b. what is the molality of the solution? *0.75°C = (0.51 °C/m) (x) → x =* **1.5m**

p. 455 PP 1-3

1. What is the expected freezing-point depression for a solution that contains 2.0 mol of magnesium sulfate dissolved in 1.0 kg of water? $\Delta T_f = K_f m$

2.0 mol $MgSO_4$/ 1.0 kg = 2.0 m x 2 moles of ions = 4.0 m

(-1.86 °C/m)(4.0 m)= **-7.4°C**

2. What is the expected boiling-point elevation of water for a solution that contains 150g of sodium chloride dissolved in 1.0 kg of water? $\Delta T_b = K_b m$

150 g NaCl/58 g/mol ÷ 1.0 kg = 2.58 mol x 2 moles of ions = 5.17 moles

(0.51 °C/m)(5.17 m) = **2.64 °C**

3. The freezing point of an aqueous sodium chloride solution is -0.20°C. What is the molality of the solution? $\Delta T_f = K_f m$ *0.20 C = (-1.86 °C/m)(x) → 0.107 m÷ 2 moles of ions =* **0.054 m NaCl**

p. 456 SR 2&3

2. Two moles of a nonelectrolyte solute are dissolved in 1kg of an unknown solvent. The solution freezes at 7.8°C below its normal freezing point. What is the molal freezing-point constant of the unknown solvent? Suggest a possible identity of the solvent. $\Delta T_f = K_f m$ *7.8°C = (x) (2m) → x =* **-3.9°C/m; acetic acid**

3. If two solutions of equal amounts in a U-tube are separate by a semipermeable membrane, will the level of the more-concentrated solution or the less-concentrated solution rise?

The more-concentrated solution

Identify the precipitate formed when 200 ml of 0.50 M solution of calcium chloride is combined with a silver nitrate solution. Write the net ionic equation, identify the spectator ions and calculate the mass of ppt. formed.

$CaCl_2$ (aq) + $AgNO_3$ (aq) → $Ca(NO_3)_2$ (aq) + 2AgCl (s)

Ag^+ (aq) + Cl^- (aq) → AgCl (s)

Spectator ions: Ca^{2+} (aq) and NO_3^- (aq)

0.50 M x 0.2 L = .1 mol $CaCl_2$ x $\frac{2 \text{ mol AgCl}}{1 \text{ mol } CaCl_2}$ x $\frac{143.32 \text{ g AgCl}}{1 \text{ mol AgCl}}$ = **28.66 g AgCl**

Bonus challenge question:

What volume of 15M HNO_3 should be added to 1250 ml of 2M HNO_3 to prepare 14 liters of 1 M HNO_3? (water is added to make the final volume exactly 14 liters).

$M_1V_1 + M_2V_2 = M_3V_3$

$(15\ M)(V_1) + (2M)(1.25\ L) = (1M)(14\ L)$

$(15\ M)(V_1) = 11.5$

$V_1 = 11.5 \div 15 = 0.76\ L$