Study Guide Chapter 12 Solutions

Please write all answers on a separate piece of paper. Be sure to show work for the problems.

SECTION 1 - SHORT ANSWER

1. Match the type of mixture on the left to its representative particle diameter on the right.

_____ solutions	**(a)** larger than 1000 nm
_____ suspensions	**(b)** 1 nm to 1000 nm
_____ colloids	**(c)** smaller than 1 nm

2. Identify the solvent in each of the following examples:

a. tincture of iodine (iodine dissolved in ethyl alcohol)

b. sea water

c. water-absorbing super gels

3. A certain mixture has the following properties:

- No solid settles out during a 48-hour period.
- The path of a flashlight beam is easily seen through the mixture.
- It appears to be homogeneous under a hand lens but not under a microscope.

Is the mixture a suspension, colloid, or true solution? Explain your answer.

4. Define each of the following terms:

a. alloy

b. electrolyte

c. aerosol

d. aqueous solution

5. For each of the following types of solutions, give an example other than those listed in **Table 1** on page 402 of the text:

a. a gas in a liquid

b. a liquid in a liquid

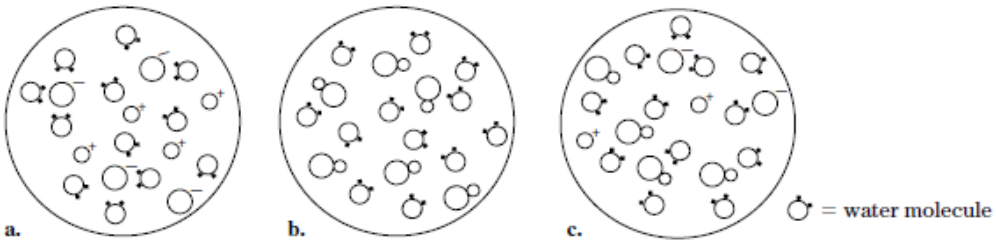
c. a solid in a liquid

6. Using the following models of solutions shown at the particle level, indicate which will conduct electricity. Give a reason for each model.

a.

b.

c.



SECTION 2 - SHORT ANSWER

1. The following are statements about the dissolving process. Explain each one at the molecular level.

a. Increasing the pressure of a solute gas above a liquid solution increases the solubility of the gas in the liquid.

b. Increasing the temperature of water speeds up the rate at which many solids dissolve in this solvent.

c. Increasing the surface area of a solid solute speeds up the rate at which it dissolves in a liquid solvent.

2. The solubility of $KClO_3$ at 25°C is 10.0 g of solute per 100.0 g of H_2O.

a. If 15 g of $KClO_3$ are stirred into 100 g of water at 25°C, how much of the $KClO_3$ will dissolve? Is the solution saturated, unsaturated, or supersaturated?

b. If 15 g of $KClO_3$ are stirred into 200 g of water at 25°C, how much of the $KClO_3$ will dissolve? Is the solution saturated, unsaturated, or supersaturated?

PROBLEMS

3. Use the data in **Table 4** on page 410 of the text to answer the following questions:

a. How many grams of LiCl are needed to make a saturated solution with 300.0 g of water at 20°C?

b. What is the minimum amount of water needed to dissolve 51 g of $NaNO_3$ at 40°C?

c. Which solute forms a saturated solution when 36 g of it are dissolved in 25 g of water at 20°C?

4. KOH is an ionic solid readily soluble in water.

a. What is its enthalpy of solution in kJ/g? Refer to the data in **Table 5** on page 416 of the text.

b. Will the temperature of the system increase or decrease as the dissolution of KOH proceeds? Why?

SECTION 3 - SHORT ANSWER

1. Describe the errors made by the following students in making molar solutions.

a. James needs a 0.600 M solution of KCl. He measures out 0.600 g of KCl and adds 1 L of water to the solid.

b. Mary needs a 0.02 M solution of $NaNO_3$. She calculates that she needs 2.00 g of $NaNO_3$ for 0.02 mol. She puts this solid into a 1.00 L volumetric flask and fills the flask to the 1.00 L mark.

PROBLEMS

2. What is the molarity of a solution made by dissolving 2.0 mol of solute in 6.0 L of solvent?

3. CH_3OH is soluble in water. What is the molality of a solution made by dissolving 8.0 g of CH_3OH in 250.0 g of water?

4. Marble chips effervesce when treated with hydrochloric acid. This reaction is represented by the following equation: $CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$

To produce a reaction, 25.0 mL of 4.0 M HCl is added to excess $CaCO_3$.

a. How many moles of HCl are consumed in this reaction?

b. How many liters of CO_2 are produced at STP?

c. How many grams of $CaCO_3$ are consumed?

5. Tincture of iodine is $I_2(s)$ dissolved in ethanol, C_2H_5OH. A 1% solution of tincture of iodine is 10.0 g of solute for 1000. g of solution.

a. How many grams of solvent are present in 1000.0 g of this solution?

b. How many moles of solute are in 10.0 g of I_2?

c. What is the molality of this 1% solution?

d. To determine a solution's molarity, the density of that solution can be used. Explain how you would use the density of the tincture of iodine solution to calculate its molarity.

MIXED REVIEW - SHORT ANSWER

1. Solid $CaCl_2$ does not conduct electricity. Explain why it is considered to be an electrolyte.

2. Explain the following statements at the molecular level:

a. Generally, a polar liquid and a nonpolar liquid are immiscible.

b. Carbonated soft drinks taste flat when they warm up.

3. An unknown compound is observed to mix with toluene, $C_6H_5CH_3$, but not with water.

a. Is the unknown compound ionic, polar covalent, or nonpolar covalent? Explain your answer.

b. Suppose the unknown compound is also a liquid. Will it be able to dissolve table salt? Explain why or why not.

PROBLEMS

4. Consider 500.0 mL of a 0.30 M $CuSO_4$ solution.

a. How many moles of solute are present in this solution?

b. How many grams of solute were used to prepare this solution?

5. a. If a solution is electrically neutral, can all of its ions have the same type of charge? Explain your answer.

b. The concentration of the OH^- ions in pure water is known to be 1.0×10^{-7} M. How many OH^- ions are present in each milliliter of pure water?

6. 90. g of $CaBr_2$ are dissolved in 900. g of water.

a. What volume does the 900.0 g of water occupy if its density is 1.00 g/mL?

b. What is the molality of this solution?

Study Guide Chapter 13
Ions in Aqueous Solutions and Colligative Properties

Please write all answers on a separate piece of paper. Be sure to show work for the problems.

SECTION 1 - SHORT ANSWER

1. Use the guidelines in **Table 1** on page 437 of the text to predict the solubility of the following compounds in water: **a.** magnesium nitrate
b. barium sulfate
c. calcium carbonate
d. ammonium phosphate

2. 1.0 mol of magnesium acetate is dissolved in water.
a. Write the formula for magnesium acetate.
b. How many moles of ions are released into solution?
c. How many moles of ions are released into a solution made from 0.20 mol magnesium acetate dissolved in water?

3. Write the formula for the precipitate formed
a. when solutions of magnesium chloride and potassium phosphate are combined.
b. when solutions of sodium sulfide and silver nitrate are combined.

4. Write ionic equations for the dissolution of the following compounds:
a. $Na_3PO_4(s)$
b. iron(III) sulfate(*s*)

5. a. Write the net ionic equation for the reaction that occurs when solutions of lead (II) nitrate and ammonium sulfate are combined.
b. What are the spectator ions in this system?

6. The following solutions are combined in a beaker: NaCl, Na_3PO_4, and $Ba(NO_3)_2$.
a. Will a precipitate form when the above solutions are combined? If so, write the name and formula of the precipitate.
b. List all spectator ions present in this system.

7. It is possible to have spectator ions present in many chemical systems, not just in precipitation reactions. Consider this example: $Al(s) + HCl(aq) \rightarrow AlCl_3(aq) + H_2(g)$ (unbalanced)
a. In an aqueous solution of HCl, virtually every HCl molecule is ionized. True or False?
b. There is only one spectator ion in this system. Is it $Al^{3+}(aq)$, $H^+(aq)$, or $Cl^-(aq)$?
c. Balance the above equation.
d. If 9.0 g of Al metal react with excess HCl according to the balanced equation in part **c**, what volume of hydrogen gas at STP will be produced? Show all your work.

8. Acetic acid, CH_3CO_2H, is a weak electrolyte. Write an equation to represent its ionization in water. Include the hydronium ion, H_3O^+.

SECTION 2 - PROBLEMS

1. a. Predict the boiling point of a 0.200 *m* solution of glucose in water.
b. Predict the boiling point of a 0.200 *m* solution of potassium iodide in water.

2. A chief ingredient of antifreeze is liquid ethylene glycol, $C_2H_4(OH)_2$. Assume $C_2H_4(OH)_2$ is added to a car radiator that is holding 5.0 kg of water.
a. How many moles of ethylene glycol should be added to the radiator to lower the freezing point of the water from 0°C to -18°C?
b. How many grams of ethylene glycol does the quantity in part **a** represent?
c. Ethylene glycol has a density of 1.1 kg/L. How many liters of $C_2H_4(OH)_2$ should be added to the water in the radiator to prevent freezing down to -18°C?
d. In World War II, soldiers in the Sahara Desert needed a supply of antifreeze to protect the radiators of their vehicles. The temperature in the Sahara almost never drops to 0°C, so why was the antifreeze necessary?

3. An important use of colligative properties is to determine the molar mass of unknown substances. The following situation is an example: 12.0 g of unknown compound X, a nonpolar nonelectrolyte, is dissolved in 100.0 g of melted camphor. The resulting solution freezes at 99.4°C. Consult **Table 2** on page 448 of the text for any other data needed to answer the following questions:

a. By how many °C did the freezing point of camphor change from its normal freezing point?

b. What is the molality of the solution of camphor and compound X, based on freezing-point data?

c. If there are 12.0 g of compound X per 100.0 g of camphor, how many grams of compound X are there per kilogram of camphor?

d. What is the molar mass of compound X?

4. Explain why the ability of a solution to conduct an electric current is not a colligative property.

MIXED REVIEW - SHORT ANSWER

1. Match the four compounds on the right to their descriptions on the left.

an ionic compound that is quite soluble in water	**(a)** HCl
an ionic compound that is not very soluble in water	**(b)** $NaNO_3$
a molecular compound that ionizes in water	**(c)** AgCl
a molecular compound that does not ionize in water	**(d)** C_2H_5OH

2. Consider nonvolatile nonelectrolytes dissolved in various liquid solvents to complete the following statements:

a. The change in the boiling point does *not* vary with the identity of the (solute, solvent), assuming all other factors remain constant.

b. The change in the boiling point varies with the identity of the (solute, solvent), assuming all other factors remain constant.

c. The change in the boiling point becomes greater as the concentration of the solute in solution (increases, decreases).

3. a. Name two compounds in solution that could be combined to cause the formation of a calcium carbonate precipitate.

b. Identify any spectator ions in the system you described in part **a**.

c. Write the net ionic equation for the formation of calcium carbonate.

4. Explain why applying rock salt (impure NaCl) to an icy sidewalk hastens the melting process.

PROBLEMS

5. Some insects survive cold winters by generating an antifreeze inside their cells. The antifreeze produced is glycerol, $C_3H_5(OH)_3$, a nonvolatile nonelectrolyte that is quite soluble in water. What must the molality of a glycerol solution be to lower the freezing point of water to -25.0°C?

6. How many grams of methanol, CH_3OH, should be added to 200. g of acetic acid to lower its freezing point by 1.30°C? Refer to **Table 2** on page 448 of the text for any necessary data.

7. The boiling point of a solution of glucose, $C_6H_{12}O_6$, and water was recorded to be 100.34°C. Calculate the molality of this solution.

8. HF(*aq*) is a weak acid. A 0.05 mol sample of HF is added to 1.0 kg of water.

a. Write the equation for the ionization of HF to form hydronium ions.

b. If HF became 100% ionized, how many moles of its ions would be released?

9. Which solution has the highest osmotic pressure?

a. 0.1 *m* glucose

b. 0.1 *m* sucrose

c. 0.5 *m* glucose

d. 0.2 *m* sucrose

Section Quiz: Types of Mixtures

1. All of the following are homogeneous mixtures *except* **a.** tomato soup.
b. a sugar-water solution.
c. gasoline.
d. a salt-water solution.

2. Which of the following is a colloid?
a. water
b. milk
c. soil
d. concrete

3. A mixture that appears to be uniform while being stirred but which separates into different phases when agitation ceases is a
a. solvent.
b. colloid.
c. suspension.
d. solute.

4. Which mixture can be separated by filtration?
a. mayonnaise
b. muddy water
c. shaving cream
d. gelatin

5. What type of solute-solvent combination is carbon dioxide in air?
a. gas-liquid
b. liquid-gas
c. liquid-liquid
d. gas-gas

6. Which is an example of a solid-liquid solution?
a. alcohol-water solution
b. oxygen-nitrogen solution
c. sugar-water solution
d. copper-nickel solution

7. When the size of the particles in a solution and in a colloid are compared, the particle size in the solution is
a. smaller.
b. larger.
c. the same size as the particle size in the colloid.
d. either smaller or larger, depending on the colloid and the solution.

8. Which mixture exhibits the Tyndall effect?
a. fog
b. salt water
c. gasoline
d. sterling silver

9. Which of the following solutions does *not* contain an electrolyte?
a. potassium bromide–water solution
b. sugar-water solution
c. hydrochloric acid solution
d. sodium chloride–water solution

10. To conduct electricity, a solution must contain
a. nonpolar molecules.
b. polar molecules.
c. ions.
d. free electrons.

Section Quiz: The Solution Process

1. Two immiscible substances are
a. water and ammonia.
b. water and ethanol.
c. carbon tetrachloride and benzene.
d. benzene and water.

2. A substance that is *not* soluble in a polar solvent is most likely
a. nonpolar.
b. ionic.
c. polar.
d. hydrogen bonded.

3. Sugar is soluble in water because sugar molecules are **a.** massive.
b. large.
c. nonpolar.
d. polar.

4. Which of the following actions does *not*, in general, increase the solubility of a solid in a liquid?
a. increasing the temperature of the solvent
b. increasing the surface area of the solute
c. increasing the pressure of the solution
d. shaking or stirring the solution

5. A solubility table shows that almost all compounds of Group 1 metals are soluble in water. This general rule tells you that
a. KI is soluble.
b. $RbNO_3$ is insoluble.
c. $CaCl_2$ is soluble.
d. CO_2 is soluble.

6. If the amount of dissolved solute in a solution at a given temperature is greater than the amount that can permanently remain in solution at that temperature, the solution is said to be
a. saturated.
b. unsaturated.
c. supersaturated.
d. diluted.

7. All of the KBr that will dissolve in a solution has dissolved, and several undissolved crystals remain on the bottom of the beaker. The solution is
a. saturated.
b. supersaturated.
c. unsaturated.
d. at the incorrect pressure to dissolve the solid.

8. How can you best increase the solubility of a gas in a liquid?

a. Increase both the temperature and the pressure.
b. Decrease both the temperature and the pressure.
c. Increase the temperature and decrease the pressure.
d. Decrease the temperature and increase the pressure.

9. The enthalpy of solution for solid $AgNO_3$ is positive. What does this tell you about the formation of a $AgNO_3$ solution?

a. $AgNO_3$ will not form a solution.
b. Energy is released during the solution process.
c. $AgNO_3$ will dissolve only under high pressure.
d. Energy is absorbed during the solution process.

10. Which statement correctly represents the equilibrium between gas molecules entering and leaving the liquid phase of a solution?

a. gas + solution ⇔ solvent
b. gas + solvent → solution
c. gas <= solvent + solution
d. gas + solvent ⇔ solution

Section Quiz: Concentration of Solutions

1. When preparing 500. mL of a 1.35 M aqueous solution of NaCl, what should you do after adding the correct amount of solute to a large beaker?

a. Add 500. mL of water, and stir until solute dissolves.
b. Add 500. mL of water, dissolve solute, and add to a volumetric flask.
c. Add 400 mL of water, dissolve solute, add to a volumetric flask, add water to 500. mL mark, and mix thoroughly.
d. Add 400. mL of water, dissolve solute, add to a volumetric flask, add 100. mL of water, mix thoroughly, and transfer to another container.

2. When preparing a 2.50 *m* aqueous solution of KOH, you correctly calculate that you need 140.3 g of KOH and 1.000 Kg (or 1.000 L) of water. What should you do after adding 140.3 g of KOH to a large beaker?

a. Add 1000. mL of water, and stir until solute dissolves.
b. Add 900. mL of water, dissolve solute, add to a volumetric flask, and then add water to the 1000. mL mark.
c. Add 900. mL of water, dissolve solute, add to a volumetric flask, add water to 1000. mL mark and mix thoroughly.
d. Add 900 mL of water, dissolve solute, add to a volumetric flask, add water to 1000. mL mark, mix thoroughly, and transfer to another container.

3. Which of the following is *not* used in preparing a 0.300 *m* aqueous solution of NaBr (molar mass = 102.89 g/mol) with 1.00 Kg of solvent?

a. 0.300 mol water
b. 0.300 mol NaBr
c. graduated cylinder
d. 0.300 mol x molar mass of NaBr

4. Which of the following statements about concentration is true?

a. A concentrated solution may be saturated.
b. A saturated solution may be dilute.
c. A dilute solution may be unsaturated.
d. All of the above

5. In some instances, the concentration of a solution is expressed as molality instead of molarity because

a. molality is easier to calculate.
b. molarity applies only to solid-liquid solutions.
c. molality does not change with changes in temperature.
d. molarity changes with the amount of solute and molality does not.

6. How many grams of $CaCl_2$ (molar mass _ 110.98 g/mol) are needed to prepare 1.00 L of a 1.00 M solution?

a. 1.00 g
b. 40.08 g
c. 75.53 g
d. 110.98 g

7. You know the mass of solute and the volume of solution. What is the first step in finding the molarity of the solution?

a. Divide the mass by molar mass to determine number of moles.
b. Divide the mass by the volume of solution.
c. Divide the volume of solution by its mass.
d. Divide the number of moles by the volume of solution.

8. A 0.15 M solution of HCl reacts with an excess of calcium carbonate, CaCO3. A volume of 25.0 mL of HCl is used. To determine the number of moles of CaCl2 produced, you need to know

a. the amount of the other product produced.
b. the molar mass of HCl.
c. the molar mass of CaCl2.
d. the balanced chemical equation for the reaction.

9. A 0.100 M solution of copper (II) nitrate reacts with an excess of iron. What do you need to know to calculate the number of moles of iron (II) nitrate produced?

a. the amount of the other product produced
b. the volume of solution
c. the molar mass of copper(II) nitrate
d. the molar mass of iron(II) nitrate

10. Which of the following is *not* used in preparing 3.00 L of a 1.25 M aqueous solution?

a. (3.75 mol x *molar mass*) of the solute
b. 3.75 mol of solute
c. (3.00 L x molar mass) of water
d. enough water to make 3.00 L of solution

Section Quiz: Compounds in Aqueous Solution

1. What happens when acetic acid, a weak electrolyte, dissolves in water?

a. Hydronium ions form.
b. The resulting solution will conduct electricity.
c. Most of the acid remains as nonionized molecules in equilibrium with ions.
d. All of the above

2. A solubility table shows that almost all compounds of Group 1 metals are soluble. This general rule tells you that

a. KI is soluble.
b. RbNO3 is insoluble.
c. CaCl2 is soluble.
d. CO2 is soluble.

3. Which solution contains the strongest electrolyte?

a. 1.50 M NaCl
b. 2.0 M $C_6H_{12}O_6$
c. 5.7 M NH_3
d. 0.80 M CH_3COOH

4. Which solution would *not* conduct an electric current?

a. NaCl
b. HCl
c. $C_6H_{12}O_6$
d. CsI

5. Which of the following is a spectator ion in the following equation? $Ag+(aq) + NO_3^-(aq) + K^+(aq) + Cl^-(aq) \rightarrow AgCl(s) + K^+(aq) + NO_3^-(aq)$

a. K+
b. Ag+
c. Cl-
d. None of the above

6. Which ions do *not* appear in the net ionic equation for the precipitation that involves solutions of $CaCl_2$ and K_2CO_3?

a. K^+ and CO_3^{2-}
b. Cl^- and CO_3^{2-}
c. Ca^{2+} and Cl^-
d. K^+ and Cl^-

7. How many moles of ions are produced by the dissociation of 0.5 mol of $MgCl_2$?

a. 0.5
b. 1.0
c. 1.5
d. 2.0

8. The process of forming a solid by combining two ionic solutions is called

a. precipitation.
b. hydration.
c. dissociation.
d. solvation.

9. Which of the following reactions is described by the net ionic equation
$Ag+(aq) + Cl-(aq) \rightarrow AgCl(s)$?

a. only the reaction between $AgNO_3$ and KCl
b. any reaction in which a precipitate of AgCl is formed
c. only the reaction between $AgNO_3$ and NaCl
d. None of the above

10. Which of the following is a hydronium ion?

a. H_2O
b. H_3O^+
c. H^+
d. HCl

Section Quiz: Colligative Properties of Solutions

1. Why is freezing-point depression a colligative property?

a. It is inversely proportional to the number of particles in a solution.
b. It is directly proportional to the number of particles in a solution.
c. It depends on the properties of an electrolyte in a solvent.
d. None of the above

2. Compared with a 0.01 M C6H12O6 solution, a 0.01 M KCl solution has

a. the same freezing-point depression.
b. about twice the freezing-point depression.
c. the same freezing-point elevation.
d. about six times the freezing-point elevation.

3. Compared with a 1.00 M NaI solution, a 1.00 M Na2SO4 solution has

a. the same boiling-point elevation.
b. about twice the boiling-point elevation.
c. a boiling-point elevation about two-thirds as high.
d. a boiling-point elevation about 1.5 times as high.

4. When a nonvolatile solute dissolves in a solvent, the vapor pressure of the solvent

a. increases.
b. decreases.
c. stays the same.
d. changes depending on the solvent used.

5. Which of the following compounds would be most effective in lowering the melting point of ice on roads?

a. $CaCl_2$
b. NaCl
c. K_3PO_4
d. K_2SO_4

6. In concentrated electrolytic solutions, the attraction between dissolved ions results in

a. higher than expected freezing points.
b. higher than expected boiling points.
c. lower than expected vapor pressure.
d. lower than expected effective concentrations.

7. What is the boiling-point elevation of a 2.0 *m* glucose solution in water? ($Kb = 0.51°C/m$)

a. 0.26°C
b. 0.51°C
c. 1.02°C
d. 98.98°C

8. What is the molal concentration of a sucrose solution whose freezing point is -2.00°C? ($Kf = 1.86°C/m$)

a. 0.26 *m*
b. 1.08 *m*
c. 3.65 *m*
d. 3.72 *m*

9. Compared with a 1.0 *m* sucrose solution in water ($Kb = 0.51°C/m$, $Kf = 1.86°C/m$), a 1.0 *m* sucrose solution in acetic acid ($Kb = 3.07°C/m$, $Kf = 3.90°C/m$) has

a. the same boiling-point elevation.
b. a lower boiling-point elevation.
c. a larger freezing-point depression.
d. a smaller freezing-point depression.

10. A carrot shrinks after being placed in a concentrated NaCl solution. This is an example of

a. freezing-point depression.
b. osmosis.
c. boiling-point elevation.
d. vapor pressure elevation.