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CHAPTER 15 STUDY GUIDE FOR CONTENT MASTERY

Solutions

Section 15.1 What are solutions?

In your textbook, read about the characteristics of solutions.

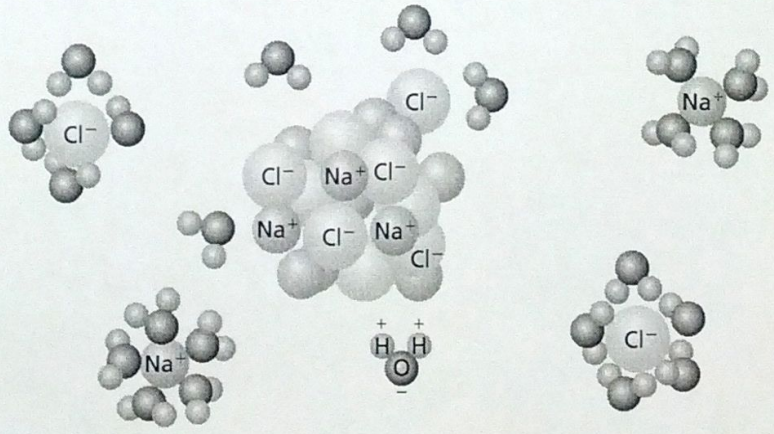
Use each of the terms below just once to complete the passage.

immiscible	liquid	soluble	solution
insoluble	miscible	solute	solvent

Air is a(n) **(1)** Solution of oxygen gas dissolved in nitrogen gas. The oxygen in air is the **(2)** solute, and nitrogen is the **(3)** Solvent. Because oxygen gas dissolves in a solvent, oxygen gas is a(n) **(4)** soluble substance. A substance that does not dissolve is **(5)** insoluble. **(6)** Liquid solutions are the most common type of solutions. If one liquid is soluble in another liquid, such as acetic acid in water, the two liquids are **(7)** miscible. However, if one liquid is insoluble in another, the liquids are **(8)** immiscible.

Read about solvation in aqueous solutions in your textbook.

The diagram shows the hydration of solid sodium chloride to form an aqueous solution. Use the diagram to answer the following questions.



9. Hydration is solvation in which the solvent is water. What is solvation?

Solvation is the process of surrounding solute particles with solvent particles to form a solution

Section 15.1 *continued*

10. As sodium chloride dissolves in water, what happens to the sodium and chloride ions?

The ions break apart from each other and become surrounded by H_2O molecules.

11. Explain the orientation of the water molecules around the sodium ions and chloride ions.

The Sodium ions are (+) and are surrounded by the oxygen ($\delta-$) end of H_2O molecules.

The chloride ions are (−) and are surrounded by the hydrogen ($\delta+$) end of H_2O molecules

12. How does the strength of the attraction between water molecules and sodium and chloride ions compare with the strength of the attraction between the sodium ions and chloride ions? How do you know?

The attraction between water molecules and sodium and chloride ions are greater than the attractions between sodium ions and chloride ions. This is why solvation occurs.

13. List three ways that the rate of solvation may be increased.

stir the solution, heat the solution, increase the surface area of the solute

In your textbook, read about heat of solution, solubility, and factors that affect solubility.

For each statement below, write *true* or *false*.

True **14.** The overall energy change that occurs when a solution forms is called the heat of solution.

False **15.** Solubility is a measure of the ~~minimum~~ maximum amount of solute that dissolves in a given amount of solvent at a specified temperature and pressure.

False **16.** Solvation continues as long as the solvation rate is ~~less~~ more than the crystallization rate.

True **17.** In a saturated solution, solvation and crystallization are in equilibrium.

True **18.** Additional solute can be dissolved in an unsaturated solution.

True **19.** The solubility of a gas dissolved in a liquid decreases as the temperature of the solution increases.

Section 15.2 Solution Concentration

In your textbook, read about expressing concentration and using percent to describe concentration.

Data related to aqueous solutions of sodium chloride (NaCl) and aqueous solutions of ethanol (C_2H_5OH) are provided in the table below. Use the table to answer the following questions. Circle the letter of the choice that best answers the question.

	Mass (g)			Volume (mL)	
Solution	NaCl	H_2O	Solution	C_2H_5OH	H_2O
1	3.0	100.0	5	2.0	100.0
2	3.0	200.0	6	5.0	100.0
3	3.0	300.0	7	9.0	100.0
4	3.0	400.0	8	15.0	100.0

1. What is the percent by mass of NaCl in solution 1? $\frac{3.0\text{g NaCl}}{3.0\text{g} + 100.0\text{g}} \times 100 = 2.9\%$

a. 0.030% **b.** 2.9% **c.** 3.0% **d.** 33%

2. Which of the following solutions is the most dilute?

a. Solution 1 **b.** Solution 2 **c.** Solution 3 **d.** Solution 4

3. What is the percent by volume of C_2H_5OH in Solution 5?

a. 0.2% **b.** 1.9% **c.** 2.0% **d.** 22% $\frac{2\text{mL}}{2\text{mL} + 100\text{mL}} \times 100 = 1.96\%$

4. Which of the following solutions is the most concentrated?

a. Solution 5 **b.** Solution 6 **c.** Solution 7 **d.** Solution 8

In your textbook, read about molarity and preparing molar solutions.

Read the following problem and then answer the questions.

An 85.0-mL aqueous solution contains 7.54 g iron(II) chloride ($FeCl_2$). Calculate the molarity of the solution.

5. What is the mass of the solute? 7.54g

6. What is the volume of the solution? 85.0 mL

7. Write the equation that is used to calculate molarity.

moles solute / liters solution

8. In what unit must the amount of the solute be expressed to calculate molarity? moles

9. In what unit must the volume of the solution be expressed to calculate molarity? liters

10. Write the expression needed to convert the volume of the solution given in the problem to the volume needed to calculate molarity. $85.0\text{mL} \times \frac{1\text{L}}{1000\text{mL}} = .085\text{L}$

Section 15.2 *continued*

11. What quantity must be used to convert the mass of the solute given in the problem to the amount of solute needed to calculate molarity?

55.85 g Fe + 2(35.45 g Cl) = 126.75 g $FeCl_2$

12. Write the expression used to calculate the amount of solute.

$7.54\text{ g} \times \frac{1\text{ mol}}{126.75\text{ g}} = 0.059487\text{ mol}$

13. Calculate the molarity of the solution. Show all your work.

$M = \frac{0.059487\text{ mol}}{.085\text{ L}} = 0.6998\ M$

or

0.7 M $FeCl_2$

In your textbook, read about molality and mole fractions.

Answer the following questions.

14. How does molality differ from molarity?

$m = \frac{\text{moles solute}}{\text{kg solvent}}$ $M = \frac{\text{moles solute}}{\text{liters solution}}$

15. Calculate the molality of a solution of 15.4 g sodium bromide (NaBr) dissolved in 125 g of water. Show all your work.

$m = \frac{\left(15.4\text{ g NaBr} \times \frac{1\text{ mol}}{102.89\text{ g}}\right)}{125\text{ g} \times \frac{1\text{ kg}}{1000\text{ g}}} = \frac{.14967\text{ mol}}{.125\text{ kg}} = 1.2\ m$

16. What is mole fraction?

$\frac{\text{moles of one part}}{\text{Total moles of all parts}}$

17. Calculate the mole fraction of HCl in an aqueous solution that contains 33.6% HCl by mass. Show all your work.

66.4% H_2O

$33.6\text{ g HCl} \times \frac{1\text{ mol}}{36.46\text{ g}} = 0.92156$

$66.4\text{ g } H_2O \times \frac{1\text{ mol}}{18.02\text{ g}} = 3.6848$

4.606 total

$\frac{0.92156}{4.606} = .2$

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Section 15.3 Colligative Properties of Solutions

In your textbook, read about electrolytes and colligative properties, vapor pressure lowering, boiling point elevation, and freezing point depression.

Use the table to answer the following questions.

Solution	Density (g/L)	Boiling Point (°C)	Freezing Point (°C)
1.0*m* C_2H_5OH(aq)	1.05	100.5	−1.8
1.0*m* HCl(aq)	1.03	101.0	−3.7
1.0*m* NaCl(aq)	1.06	101.0	−3.7
2.0*m* NaCl(aq)	1.12	102.1	−7.4

1. Which properties in the table are colligative properties?

boiling point, freezing point

2. What can you conclude about the relationship between colligative properties and the number of ions in solution from the 1.0*m* NaCl(aq) and 2.0*m* NaCl(aq) solutions?

The more ions in solution, the greater the change in b.p. & f.p.

3. What can you conclude about the relationship between colligative properties and the type of ions in solution from the 1.0*m* HCl(aq) and 1.0*m* NaCl(aq) solutions?

The type of ion has no effect.

Suppose that in a simple system, a semipermeable membrane is used to separate a sucrose-water solution from its pure solvent, water. Match the descriptions of the system in Column A with the terms in Column B.

Column A	Column B
d **4.** Cannot cross the semipermeable membrane	**a.** osmotic pressure
b **5.** Can cross the semipermeable membrane	**b.** water molecules
f **6.** The side that exerts osmotic pressure	**c.** semipermeable membrane
e **7.** The diffusion of the solvent particles across the semipermeable membrane from the area of higher solvent concentration to the area of lower solvent concentration	**d.** sugar molecules
	e. osmosis
C **8.** The barrier with tiny pores that allow some particles to pass through but not others	**f.** solution side
	g. pure solvent side
g **9.** The side from which more water molecules cross the semipermeable membrane	
a **10.** A colligative property of solutions	

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Section 15.4 Heterogeneous Mixtures

In your textbook, read about suspensions and colloids.

For each statement below, write *true* or *false*.

false 1. A solution is a mixture containing particles that does not settle out of the mixture if left undisturbed.

true 2. The most abundant substance in a colloid is the dispersion medium.

false 3. A colloid can cannot be separated by filtration.

true 4. A solid emulsion consists of a liquid dispersed in a solid.

true 5. Whipped cream is an example of a foam.

false 6. In an aerosol, the dispersing medium is a liquid. gas

true 7. Brownian motion results from the collisions of particles of the dispersion medium with the dispersed particles.

true 8. Dispersed particles in a colloid do not tend to settle out because they have polar or charged atomic groups on their surfaces.

false 9. Stirring an electrolyte into a colloid stabilizes destroys the colloid.

true 10. Colloids demonstrate the Tyndall effect.

The table below lists the characteristics of particles in colloids, solutions, and suspensions. Place a check in the column of each mixture whose particles have a particular characteristic.

Characteristics of Particles	Colloid	Solution	Suspension
11. Less than 1 nm in diameter		X	
12. Between 1 nm and 1000 nm in diameter	X		
13. More than 1000 nm in diameter			X
14. Settle out if undisturbed			X
15. Pass through standard filter paper	X	X	
16. Lower vapor pressure			
17. Scatter light	X		X