CHAPTER 13 – Properties of Solutions

Section 13.1 – The Solution Process

(a) A homogeneous mixture is also known as a solution. The ability of substances to form solutions depends on two factors:

(1) _____

(2) _____

(b) The mixing of gases is a **spontaneous** process, meaning _____

_____

(c) Entropy is a topic that will be explored in more detail in Chapter 19. As two or more substances mix together to form a solution, the entropy of the system increases. Give a brief summary of entropy, as defined on page 790 in your textbook.

(d) Two different gases, no matter if they are polar or nonpolar, will mix spontaneously with each other when they are combined in one container. This can be explained because the intermolecular forces in gases are too _____ to prevent the molecules from mixing with each other.

(e) When a solution is formed, there are three kinds of interparticle interactions involved:

(1) _____ interactions must be overcome before the solute particles can be dispersed throughout the solvent.

(2) _____ interactions must be overcome in order to "make room for" the solute particles in the solvent.

(3) _____ interactions are formed as the particles mix together.

(f) Interactions (1) and (2) described in part (e) are classified as (endothermic exothermic), and interaction (3) is classified as (endothermic exothermic).

(g) When pentane (C_5H_{12}) mixes with heptane (C_7H_{16}), what type of attractive forces must be broken? _____

What type of attractive forces are formed? _____

(h) When NaCl dissolves in H_2O, what type of attractive forces must be broken in the solute? _____ What type of IMFs must be broken in the solvent? _____ What type of IMFs are formed between the solute and the solvent? _____

(i) Interactions between solute and solvent are known as solvation. When water is the solvent, these interactions are known as _____

(j) NaCl does not dissolve in nonpolar solvents such as hexane (C_6H_{14}) because _____

_____

_____

(k) For each of the following mixtures, describe what types of intermolecular forces are dominant in the attractions between the solute and the solvent.

(i) Turpentine ($C_{10}H_{16}$) dissolves in toluene (C_7H_8): _____

(ii) Bromoethane (CH_3CH_2Br) dissolves in acetonitrile (CH_3CN): _____

(iii) Acetic acid (CH_3COOH) dissolves in water: _____

(iv) Potassium nitrate (KNO_3) dissolves in water: _____

(l) Refer to Figure 13.4 on page 517.

In the diagram on the left, the solution process is _____ and the sign of ΔH_{soln} is _____. This can be explained because the total energy that is _____ when solvent-solvent and solute-solute interactions are broken is _____ than the energy that is _____ when the solute and the solvent form interactions with each other.

(m) Refer to Figure 13.4 on page 517.

In the diagram on the right, the solution process is _____ and the sign of ΔH_{soln} is _____. This can be explained because the total energy that is _____ when solvent-solvent and solute-solute interactions are broken is _____ than the energy that is _____ when the solute and the solvent form interactions with each other.

(n) When nickel metal dissolves into hydrochloric acid, is this classified as a physical change or a chemical change? _____

If the resulting solution (which contains nickel(II) ions) is evaporated to dryness, what solid substance will be obtained? _____

Section 13.2 – Saturated Solutions and Solubility

(a) Write a chemical equation for the process of dissolving sucrose ($C_{12}H_{22}O_{11}$) into water. Do not use H_2O in your equation.

(b) Write a chemical equation for the process of dissolving potassium bromide into water. Do not use H_2O in your equation.

(c) What is a dynamic equilibrium? (See page 443.)

(d) What are the two opposing processes that occur in a saturated solution?

(e) Define the following terms.

solubility

supersaturated

(f) Refer to Figure 13.9. As this process shown in the pictures occurs (from left to right), the outside of the beaker feels quite warm. This means that the process of dissolving sodium acetate in water is (endothermic exothermic) and the process of crystallization of sodium acetate is (endothermic exothermic).

Section 13.3 – Factors Affecting Solubility

(a) Explain why xenon gas is more soluble in water than helium gas.

(b) "Goo Gone" is a liquid product used to remove stains such as adhesive residues, grease, and wax. This product contains petroleum distillates. Why does it seem likely that Goo Gone is able to dissolve greasy stains and residues? Discuss polarity and intermolecular forces.

(c) Bartenders and chemists know that water mixes very well with ethanol. Why is this the case? Discuss polarity and intermolecular forces.

(d) In terms of polarity and intermolecular forces, explain why the two liquids shown in Figure 13.10 are immiscible.

(e) Both methanol and hexanol contain an –OH group, which is supposed to form hydrogen bonds with water. Explain why hexanol is much less soluble in water than methanol is.

(f) Hexanol is much more soluble in _____ than methanol is.

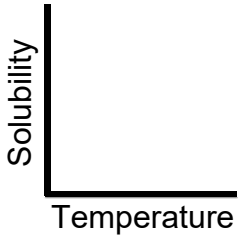
(g) Explain the meaning of the phrase "like dissolves like" with respect to solution formation.

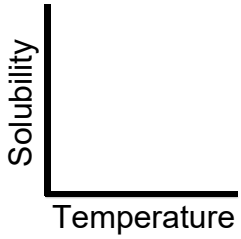
NOTE: AP Chemistry graders do not award points for the phrase "like dissolves like." You'll have to be more specific about the polarity of the solute and the solvent and mention the specific type of IMFs that are involved in order to receive full credit.

(h) As the partial pressure of a gas above a solvent increases, how does this affect the solubility of that gas?

(i) Before you open a bottle of soda, you don't see many bubbles in the solution (unless you shake it up.) After you open a bottle of soda, bubbles are more visible in the solution. These bubbles rise to the surface and pop. Discuss the solubility of CO_2 in soda, both before and after the bottle is opened. See Figure 13.16.

(j) On the two graphs below, sketch the general shape of the curve for potassium nitrate (left) and oxygen gas (right).





(k) Explain why bubbles tend to form on the inside wall of a pot when water is heated on the stove, even though the water temperature is well below the BP of water.

Section 13.4 – Expressing Solution Concentration

Section 13.5 – Colligative Properties

According to the AP Chemistry Exam Description:

"Solution composition can be expressed in a variety of ways; molarity is the most common method used in the laboratory. Molarity is defined as the number of moles of solute per liter of solution. Understanding how to prepare solutions of specified molarity through direct mixing of the components, through use of volumetric glassware, and by dilution of a solution of known molarity with additional solvent is important for performing laboratory work in chemistry. Colligative properties are beyond the scope of this course and the AP Exam and are therefore considered prior knowledge and not directly assessed on the exam. Calculations of molality, percent by mass, and percent by volume are beyond the scope of this course and the AP Exam."

Section 13.6 – Colloids

This section presents information that is interesting, but not included in the AP Chemistry curriculum and will not be covered on the AP Exam.