Chapter 12
Study Guide – Answers

Name: ______________________

Date:________________ Per:________

1. Define the following terms: (You're on your own for these.)
   a. Solution: ____
   b. Solute: ____
   c. Solvent: ____
   d. Saturated: ____
   e. Unsaturated: ____
   f. Supersaturated: ____
   g. Miscible: ____
   h. Immiscible: ____
   i. Electrolyte: ____
   j. Non-Electrolyte: ____
   k. Aqueous solution: ____
   l. Concentrated: ____
   m. Dilute: ____

2. Define the steps in solution formation. Where does solution formation occur?
   Solvation: The attachment (through intermolecular forces) of solvent particles to solute particles at the surface of the solute.
   Dissociation: The separation of solute particles and distribution of the solute particles throughout the solution. Solution formation occurs at the surface of the solute where solvent and solute can collide.

3. How is energy involved in solution formation? Breaking solute-solute attractions and solvent-solvent attractions requires an input of energy (endothermic) and the formation of solute-solvent attractions releases energy (exothermic).

4. Explain "like dissolves like": Polar solvents dissolve polar solutes. Non-polar solvents dissolve non-polar solutes. When polar substances are combined with non-polar substances, the polar substances stick together and do not mix with the non-polar substance.

5. What must be true for a given solute to dissolve in a specified solvent? The attractions between the solute and solvent particles must be greater than the attractions holding the solvent/solute together in their pure states.

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6. Explain the three things that affect solubility.
   a. *Nature of the solute/solvent:* the particles must be able to mix either because they are attracted to one another or because they are not sufficiently attracted to themselves to prevent mixing (like dissolves like)
   b. *Temperature:* increasing the temperature generally increases the solubility due to weakening of intermolecular forces between particles (dissolved gases, however, experience a lowering of solubility at high temperatures)
   c. *Pressure:* (only significant with dissolved gases) increasing pressure of a gas forces more particles into an equal volume – Henry's Law – solubility of a gas dissolved in a liquid is proportional to the partial pressure of that gas above the liquid
7. Explain the four things that affect rate of solution
   a. *Surface area:* increasing the surface area over which the solvent and solute can interact increases the collisions and increases the likelihood of solvation occurring
   b. *Stirring:* stirring increases the collisions between solvent and solute particles increasing the likelihood of solvation
   c. *Temperature:* increasing the temperature of the mixture weakens the intermolecular forces of the pure solvents and solutes allowing dissociation to occur (increasing the temperature slows the dissolution of gases in liquids as it makes it difficult for the gaseous solute to solvate
   d. *Amount of solute already dissolved:* solution formation initially occurs rapidly but slows as dissociated solute particles interfere with the solvation of additional solute particles
8. How is a supersaturated solution made? By creating a saturated solution at a high temperature, removing the undissolved solute (necessary for a saturated solution, but unwanted nucleation sites for a supersaturated solution), and slowly cooling the solution.
9. How do you calculate a percentage by mass (or volume)? What are the units? percentage by mass = (mass solute/total mass of solution) x 100 and percentage by volume = (volume solute/total volume of solution) x 100 (there are no units – they're percentages, so make sure you list the '%' sign)
10. How do you calculate molarity? What are the units? *M* = moles solute/liters of solution (mol/liter or *M*)
11. How do you calculate molality? What are the units? *m* = moles solute/kg solvent (mol/kg or *m*)
12. How do you calculate mole fractions? What are the units? *Mole fraction (X) = moles solute/total moles of solution (there are no units – it's a fraction)*
13. How are parts per million and parts per billion similar to percentages? What is different in the calculation? PPM and PPB are both scaled ratios like percentages (parts per hundred), but instead of multiplying the ratio by 100, the ratio is multiplied by 1.0×10^6 (for PPM) or 1×10^9 (for PPB)
14. Calculate the percentage by mass of 120. g NaCl in 200. g water.

Total solution = 120. g solute + 200. g solvent = 320. g solution

120. g / 320. g x 100 = **37.5%**

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15. Calculate the percentage by volume of 15.3 mL CH_3COOH in 76.5 mL water.

Total solution = 15.3. mL solute + 76.5 mL solvent = **91.8 mL solution**

15.3 mL / 91.8 mL x 100 = **16.7 %**

16. Calculate the mole fraction of 0.500 moles of NaCl in 4.00 moles of solution

0.500 / 4.00 = **0.125**

17. Calculate the concentration in PPM of 10.2 g NaCl in 2.00 x 10^7 g solution.

(10.2 g / (2.00 x 10^7 g)) x 1 000 000 = **0.510 PPM**

18. What is the molarity of a NaOH solution that contains 40.0g of solute in 0.25 liters? *Convert from mass to moles for your calculation.*

$$\frac{40.0 \text{ g NaOH}}{} \times \frac{1 \text{ mol NaOH}}{40.0 \text{ g NaOH}} = 1.00 \text{ mol NaOH}$$

1.00 mol NaOH / 0.250 liters solution = **4.00 *M***

19. How many grams of KNO_3 must be dissolved in 500. mL of water to make a 0.200 molar solution? (*Convert mL to L. Solve the molarity equation for # of moles, then convert moles to grams.)*

0.200 M = x / 0.500 liters

x = 0.100 mol

$$\frac{0.100 \text{ mol } KNO_3}{} \times \frac{101.912 \text{ g } KNO_3}{1 \text{ mol } KNO_3} = 10.2 \text{ g } KNO_3$$

20. 250. mL of 0.100 *M* lithium acetate solution is diluted to a volume of 750. mL, what will the concentration of this solution be?

V_1 = 250. mL
M_1 = 0.100 *M*
M_2 = ? *M*
V_2 = 750. mL

$M_1V_1 = M_2V_2$

$M_2 = (M_1V_1)/ V_2$

M_2 = (0.100M • 250.mL)/ 750. mL = **0.03333 *M***

21. Describe how 250. mL of 1.0 M HCl can be made from a stock solution of 6.0 M HCl.

V_1 = ?
M_1 = 6.0 *M*
M_2 = 1.0 *M*
V_2 = 250. mL

$M_1V_1 = M_2V_2$

$V_1 = (M_2V_2)/ M_1$

V_1 = (1.0M • 250.mL)/ 6.0M = **41.6 mL**

Measure a volume of 42 mL of 6.0 M HCl, add to a 250 mL volumetric flask and add water to dilute to a final volume of 250 mL. (Approximately 200 mL water should be added to the volumetric flask first, then acid, to avoid spattering. The final dilution may be accomplished after the concentrated acid is significantly diluted.)

22. Why is an ionic compound like NaCl more soluble in water than a covalent compound like CO_2?

Water is a strongly polarized molecule (very sticky). There is a greater attraction between fully charged particles like ions (also very sticky) and water than there is between non-polar molecules like CO_2 (not sticky) and water.

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