Chemistry 1 Name _____KEY_____
Unit 4 ALT 4c Study Guide –Solutions & Mole Ratio Period _____ Date _____

THIS COMPLETED STUDY GUIDE IS DUE 4/15/16 AS PART OF THE UNIT 4c PACKET #3.

Part 1: Vocabulary. Write a short definition of each term in your own words.

Solution (p. 402) 2 or more substances in a mixture that is homogeneous throughout.
Solvent (p. 402) A substance in which something else is dissolved to form a solution.
Solute (p. 402) A substance that is dissolved in a solvent to make a solution. Koolaid is a solute when dissolved in water to make the drink.

Molarity (p. 403) The concentration of dissolved substances in a solution calculated as moles of solute per liter of solution.
Mole ratio (p. 457) The ratio of one reactant or product to another in a balanced chemical reaction.
Stoichiometry (p. 462) The quantitative relationship between amounts of reactants and products in a chemical reaction.

Solution Chemistry

1. Write the mathematical equation for molarity:

Molarity (M) = $\frac{\text{moles of solute}}{\text{Liters of solution}}$ The units of molarity are moles per liter

2. Determine the molarity of each of the following. Show all calculations and include correct units.

a. 0.10 moles of NaCl in 1.0 L of solution

Molarity (M) = $\frac{0.10 \text{ moles}}{1 \text{ L}}$ = 0.10 mol/L = 0.10 M

b. 0.50 mol of NaCl in 1.0 L of solution

Molarity (M) = $\frac{0.50 \text{ moles}}{1 \text{ L}}$ = 0.50 mol/L = 0.50 M NaCl

c. 0.10 mole of NaCl in 0.50 L of solution

Molarity (M) = $\frac{0.10 \text{ moles}}{0.5 \text{ L}}$ = 0.2 mol/L = 0.2 M NaCl

d. 0.10 mol NaCl in 250 mL of solution

Molarity (M) = $\frac{0.10 \text{ moles}}{0.25 \text{ L}}$ = 0.4 mol/L = 0.4 M NaCl

3. What is the concentration in moles per liter of a 250-mL solution that contains 16.0 grams of dissolved sugar ($C_{12}H_{22}O_{11}$)?

a. First calculate the molar mass of sugar:
M.M= 12x(12.01) + 22x(1.01) + 11x(16) = 342.3 g/mol
b. Next, convert the mass of sugar to moles by using the molar mass as the conversion factor:
? moles sugar = 16.0 g sugar x $\frac{1 \text{ mol sugar}}{342.3 \text{ g sugar}}$ =0.0467 = **0.047 moles sugar**
c. Then convert mL to L of solution using the equality 1.0 Liters = 1000 milliliters
? liters = 250 mL x $\frac{1 \text{ L}}{1000 \text{ mL}}$ = **0.250 L**
d. Now calculate the molarity of the sugar solution using your answers to parts (b) and (c).
Molarity (M) = $\frac{0.047 \text{ moles}}{0.250 \text{ L}}$ = **0.188 mol/L = 0.188 M**

Solution Practice

4. Determine the molarity of each of the following solutions and then list them in order of increasing molarity:

a. 29.2 g of NaCl in 0.50 L of solution

(1) Molar Mass NaCl: 22.99 + 35.45=58.4 g/mol

(2) ? moles NaCl = 29.2 g NaCl x $\frac{1 \text{ mol NaCl}}{58.4 \text{ g NaCl}}$ = 0.5 mol NaCl

(3) Molarity (M) = $\frac{0.5 \text{ moles NaCl}}{0.5 \text{ L}}$ = 1.0 mol/L = 1.0 M NaCl

b. 5.8 g of NaCl in 50 mL of solution

(1) ? moles NaCl = 5.8 g NaCl x $\frac{1 \text{ mol NaCl}}{58.4 \text{ g NaCl}}$ = 0.0.099 = 0.10 mol NaCl

(2) ? liters = 50 mL x $\frac{1 \text{ L}}{1000 \text{ mL}}$ = **0.05 L**

(3) Molarity (M) = $\frac{0.10 \text{ moles NaCl}}{0.05 \text{ L}}$ = 2.0 mol/L = 2.0 M NaCl

c. 2.9 g of NaCl in 10.2 mL

(1) ? moles NaCl = 2.9 g NaCl x $\frac{1 \text{ mol NaCl}}{58.4 \text{ g NaCl}}$ = 0.04966 = 0.050 mol NaCl

(2) ? liters = 10.2 mL x $\frac{1 \text{ L}}{1000 \text{ mL}}$ = **0.0102 L**

(3) Molarity (M) = $\frac{0.050 \text{ moles NaCl}}{0.0102 \text{ L}}$ = 4.9 mol/L = 4.9 M NaCl

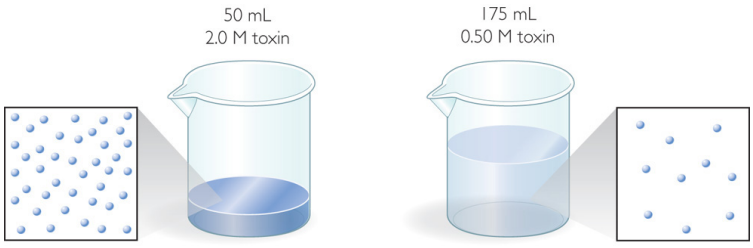
5. Which of the following correctly describes how you can increase the molarity of a solution?

A. Add solute. C. Pour out some of the solution.
B. Add solvent. D. All of the above.

6. When expressing the molarity of a solution, the M stands for?

A. Atoms per liter of water. C. Atoms per milliliter of solution.
B. Moles per milliliter of solvent **D. Moles per liter of solution**

7. **Challenge**: Which beaker contains the larger dose of a toxic substance? Explain with quantitative evidence. SHOW ALL CALCULATIONS and then write your answer in a complete sentence.



Beaker has 0.050 L of 2 M toxin vs Beaker with 0.175 L of 0.50 M toxin.
Calculate moles of toxin in each beaker and compare:
2 M Toxin: ? mol solute = 2.0 M toxin= 2.0 mol/L x 0.050 L = 0.10 moles toxin
0.50 M toxin: ? mol solute = .50 M toxin= 0.50 mol/L x 0.175 L = 0.0875= 0.09 moles toxin
The beaker on the left contains more moles of toxin per liter than the beaker on the right, which makes it more concentrated.

Mole Ratio and Stoichiometry

A balanced chemical reaction is like a recipe. It gives the ratio of reactants to combine to make the product(s). Complete ALL of the items in this section so that you get enough practice to succeed. SHOW ALL WORK that supports your answer.

8. Balance the following chemical equations. Show your inventory!

a. __Zn(s) + __2_HCl(aq) → ___$ZnCl_2$(aq) + ___H_2(*g*)

b. ___2_$KClO_3$(s)→ ___2KCl(s) + ___$3O_2$(g)

c. ___$SbCl_5$(s) + _5__HF(aq)→ ___SbF_5(g) + __5_HCl(aq)

d. ___4Fe(s) + ___$3O_2$(g) → ___$2Fe_2O_3$(s)

9. For the following equation, answer parts (a)-(e). Show all work and calculations. Include units!

___$Mg(OH)_2$(*s*) + ___2HCl(*aq*)→ ___$MgCl_2$(*aq*) + ___$2H_2O$(*l*)

a. Balance the chemical equation.

b. What is the mole ratio of $Mg(OH)_2$ to $MgCl_2$ produced?

Mole ratio of $Mg(OH)_2$:$MgCl_2$ is 1:1

c. If you start with 4 moles of $Mg(OH)_2$ how many moles of $MgCl_2$ will be produced?

? mol $MgCl_2$ = 4 mol $Mg(OH)_2$ x $\frac{1 \text{ mol } MgCl_2}{1 \text{ mol } Mg(OH)_2}$ = 4 mol $MgCl_2$

d. Calculate the molar masses of $Mg(OH)_2$ and $MgCl_2$. Include correct units!

M.M. $Mg(OH)_2$ = 24.31 + 2x(16) + 2(1.01) = 24.31 + 32 + 2.02 = 58.3 g/mol
M.M. $MgCl_2$ = 24.31 + 2x(35.45) = 95.2 g/mol

e. How many grams of $MgCl_2$ can be produced from 5.0 grams of $Mg(OH)_2$?

? g $MgCl_2$ = 5.0 g $Mg(OH)_2$ x $\frac{1 \text{ mol } Mg(OH)_2}{58.3 \text{ } Mg(OH)_2} \times \frac{1 \text{ mol } MgCl_2}{1 \text{ mol } Mg(OH)_2} \times \frac{95.2 \text{ g } MgCl_2}{1 \text{ mol } MgCl_2}$ = 8.17 g $MgCl_2$

10. For the following equation, answer parts (a)-(e). Show all work and calculations. Include units!

___**3**$CaCl_2(aq)$ + ___**2**$Na_3PO_4(aq)$→ ___$Ca_3(PO_4)_2(s)$ + ___**6**$NaCl(aq)$

a. Balance the chemical equation [Since PO_4 is on both sides you can inventory it as a group!]

b. What is the mole ratio of $CaCl_2$ to $Ca_3(PO_4)_2$?

Mole ratio of $CaCl_2$:$Ca_3(PO_4)_2$ is 3:1

d. Calculate the molar masses of $CaCl_2$ and $Ca_3(PO_4)_2$. Include correct units!

M.M. of $CaCl_2$ = 40.08 + 2x(35.45) = 110.98 = 111.0 g/mol

M.M. of $Ca_3(PO_4)_2$ = 3 x (40.08) + 2 x (30.97) + 8 x (16.0) = 310.2 g/mol

e. If you start with 13.5 g of $CaCl_2$, how many grams of $Ca_3(PO_4)_2$ will be produced?

? g $Ca_3(PO_4)_2$ = 13.5 g $CaCl_2$ x

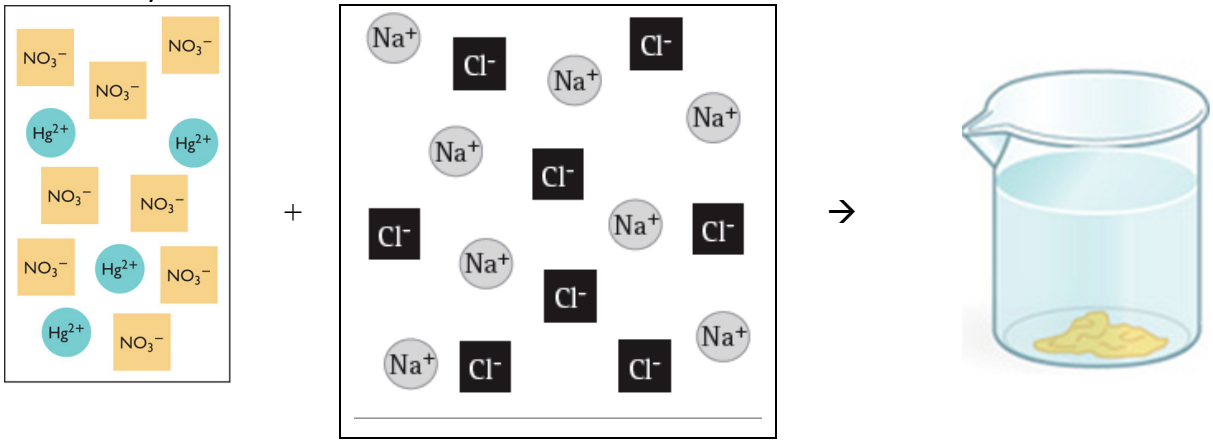
12.6 g of $Ca_3(PO_4)_2$ will be produced.

11. Challenge: Consider the reaction to remove toxic mercury from a water source by precipitation:

$Hg(NO_3)_2(aq)$ + 2$NaCl(aq)$→ $HgCl_2(s)$ + 2$NaNO_3(aq)$

On the paper, draw a diagram that shows the correct amount of sodium chloride needed to react with the amount of mercury (II) nitrate represented in the box below:

Look at the balanced chemical reaction to see the mole ratio is 1 formula unit of $Hg(NO_3)_2$ for every 2 formula units of NaCl. Then in the particle view there are 4 formula units of $Hg(NO_3)_2$ which means you need to draw 2 times that for NaCl. This would be 8 Na ions and 8 Cl ions.



b. What else is present in the beaker at the end of the reaction, besides the solid $HgCl_2$?

A solution of sodium nitrate, $NaNO_3$ is also in the beaker.

c. Why aren't there any mercury ions left over at the end? All of the mercury ions precipitate out as HgCl2 and so there are none left in the solution.