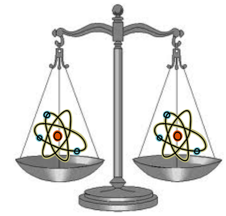
STOICHIOMETRY Packet



Name:______________________________________Period:______Date:____________

I. _______________________________= a quantitative study dealing with relationships between the amounts of reactants and products in a chemical reaction.

- Comes from the Greek words *stoicheion*, meaning "element" and *metron*, meaning "measure".
- Based on chemical equations and the ____________________________(matter cannot be either created or destroyed in ordinary chemical or physical means).
  - Mass of the reactants EQUALS the mass of the products!
- If you know the amount of one substance in a reaction, then you can determine the amounts of all of the other substances.
- All stoichiometry problems are solved by converting the _______________into the units that you are looking for (moles or grams). A T-chart is used to obtain the correct answer.

II. What is the role of a mole ratio in reaction stoichiometry problems?

- ______________________= conversion factor that relates the number of moles of any two substances involved in a chemical reaction.
  - Obtained directly from the __________________chemical equation.
  - Remember: _________________________in a chemical equation satisfy the law of conservation of matter and represent the relative numbers of _____________ of reactants and products.
- Interpret the following BALANCED equation:

$$\mathbf{2}\ Al_2O_3\,(l) \rightarrow \mathbf{4}\ Al\,(s) + \mathbf{3}\ O_2\,(g)$$

- o ____*moles of* Al_2O_3 *decompose to produce* ___*moles of Al and* ___ *moles of* O_2.
  - What is the mole ratio between aluminum oxide and aluminum?

  - What is the mole ratio between aluminum and oxygen?

  - What is the mole ratio between aluminum oxide and oxygen?

III. Solving Stoichiometry Problems:

> ***Conversion Factor to Remember:***
> ***1 mole of a substance = molar mass of that substance (grams)***

Step 1: Write the balanced equation

Step 2: What do you know? What are you looking for?

SET UP YOUR PROBLEM!!!

Step 3: Make a T-chart being sure that UNITS CANCEL OUT. Always start the T-chart with your given information!

***Ex 1:* MASS-MASS Relationship: (given→moles) (mole ratio) (unknown → g)**

Given (grams)	1 mol Given	Unknown moles (coefficient)	Unknown's molar mass(grams)
	Given's molar mass (grams)	Given moles (coefficient)	1 mol unknown

Sodium chloride is produced from its elements through a synthesis reaction. What mass of sodium is required to produce 25 g sodium chloride?

Balanced Equation=____

***Ex 2:* MASS-MOLE Relationship: (given→moles) (mole ratio)**

Given (grams)	1 mol Given	Unknown moles (coefficient)
	Given's molar mass (grams)	Given moles (coefficient)

How many moles of iron (II) bromide would be needed to react with potassium phosphate to produce 18.54g of iron (II) phosphate?

Balanced Equation=____

Ex 3: How many grams of calcium sulfide would be needed to react with 6.32g of silver nitrate to form silver sulfide and calcium nitrate?

Balanced Equation=____

Practice Problems: *Solve the following problems. Show all work. Include units on all numbers.*

0.38

1. If 0.06g of aluminum reacts with sulfuric acid. How many grams of aluminum sulfate are produced?

Balanced Equation:____

13.3

2. Hydrogen gas and oxygen gas react together to produce water. If 15g of water is formed, what mass of oxygen gas was needed in the reaction?

Balanced Equation:____

1.1

3. Ammonia (NH_3) is produced when hydrogen and nitrogen gases react together. How many <u>moles</u> of nitrogen are needed to make 36g of ammonia?

Balanced Equation:____

13.3

4. Carbon dioxide and water are produced when glucose ($C_6H_{12}O_6$) and oxygen react together. If 12.5 g of glucose is used, how many g of oxygen must be present?

Balanced Equation:____

0.92

5. How many grams of sulfuric acid would be required to react with 0.75 g of sodium hydroxide?

Balanced Equation:____

0.11

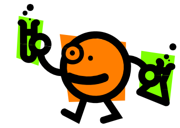
6. How many moles of oxygen are required to react with zinc iodide to produce 56.29g of iodine?

Balanced Equation:____

124.1

7. Potassium chlorate decomposes and produces 80.5 g of oxygen. What would be the mass of the other product, potassium chloride?

Balanced Equation:____



<u>PRACTICE PROBLEMS #2:</u> Solve the following problems. *First write the balanced equations! Show all work. Include units on all numbers.*

78.3

1. If 20.0g of magnesium react with hydrochloric acid, how many grams of magnesium chloride are produced?

Balanced Equation:____

6.03

2. If 10.0g of sodium chloride are produced, how many grams of chlorine gas must be reacted with sodium iodide?

Balanced Equation:____

2.26

3. Sodium chlorate decomposes into sodium chloride and oxygen. How many grams of oxygen are produced in the decomposition of 5.00 g of sodium chlorate?

Balanced Equation:____

0.012

4. In a single displacement reaction of zinc and silver nitrate, how many moles of zinc are required in this reaction when 4.00 g of silver nitrate is present?

Balanced Equation:____

0.203

5. If 22.5 g of calcium hydroxide reacts with aluminum chloride, how many moles of aluminum hydroxide would be produced?

Balanced Equation:____

18.6

6. If sulfuric acid reacts with 30.0g of sodium chloride, how many grams of hydrogen chloride are produced?

Balanced Equation:____

8.4

7. How many grams of silver phosphate are produced if 10.0g of silver acetate react with sodium phosphate?

Balanced Equation:____

20.4

8. In a neutralization reaction of sodium hydroxide and sulfuric acid, the products are water and sodium sulfate. How many grams of sodium hydroxide are needed to react with 25.0g of sulfuric acid?

Balanced Equation:____

Even More Stoichiometry Problems!!

25.9

1) If 33.86 grams of silver nitrate reacts with barium chloride, a precipitate of silver chloride is produced. How many grams of barium nitrate would be produced?

Balanced Equation:____

0.23

2) If 0.078 moles of aluminum react with acetic acid, how many grams of hydrogen are produced?

Balanced Equation:____

0.04

3) If 15.22 g of mercury (II) oxide decompose, how many moles of oxygen can be produced?

Balanced Equation:____

29.9

4) Suppose a chemistry student mixes a sodium chloride solution with a silver nitrate solution and notices a precipitate later identified as silver chloride. If 0.515 mol of silver chloride is recovered, what mass of sodium chloride was needed?

Balanced Equation:____

0.15

5) How many moles of calcium hydroxide will be needed to react completely with 10 grams of phosphoric acid?

Balanced Equation:____

55.0

6) How many grams of calcium chloride are produced, if you react hydrochloric acid with 20 grams of calcium?

Balanced Equation:____

0.52

7) How many grams of hydrogen are produced when 4.72 grams of aluminum are reacted with sulfuric acid?

Balanced Equation:____

9.31

8) How many grams of water are produced when 15 grams of magnesium hydroxide are reacted with sulfuric acid?

Balanced Equation:____

IV. Calculating Percent Yield:

1) ________________________________= maximum amount of product that can be produced from a given amount of reactant

   a) Theoretical yields are calculated using ______________________________problems.

2) _________________________________= a measured amount of product obtained from a chemical reaction

   a) Actual yield must be determined ___________________________or given in a problem.

3) The actual yield for a product is usually LOWER than the theoretical yield for a product. Some reasons include:

   a) Some reactant may be used up in_____________________________.

   b) A product must often be purified and some product may be __________during purification.

4) __________________= the actual yield of a product as a percentage of the theoretical yield

5) $$\textbf{Percent yield} = \frac{\textbf{actual yield}}{\textbf{theoretical yield}} \times \mathbf{100}$$

6) Suppose the theoretical yield for the product of a chemical reaction is 3.67g CO_2 and 3.11 g CO_2 is actually collected. Calculate the percent yield for this product.

7) Suppose the theoretical yield for the product of a chemical reaction is and 10.7 g SO_2 and 9.49 g SO_2 is actually collected. Calculate the percent yield for this product.

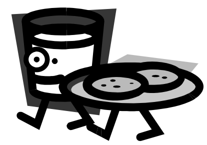
8) Chemists need to know how efficient a reaction is in producing the desired product. One way of measuring efficiency is by means of % yield. *So ideally we would like the see the % yield close to_________!*

V. LIMITING & EXCESS REACTANTS

- ______________________________**=** the reactant that limits the amount of the other reactants that can combine, and the amount of products formed in a chemical reaction.
- ______________________________**=** the substances that is not used up completely in a reaction.

Each reaction has a limiting reactant. It works the same way as in baking. Imagine if you were to go home and mix up a batch of cookie dough to make your favorite chocolate chip cookies and discover that your little brother has been eating the chocolate chips as after-school-snacks and there are not enough chips left to make the whole batch of dough into chocolate chip cookies. The amount of chocolate chips limits the number of chocolate chip cookies you can make. You will have to decide what else you can put in the batter to make a different kind of cookie.

In chemical reactions, one of the reactants will run out before the other, this is the ____________________________because it controls how much product will be made. The reactant that is left over (like the left over cookie dough without chocolate chips) is the_______________________________________.



To determine which reactant is limiting and which is in excess you must do TWO stoichiometry problems. You will be given two pieces of information and you must use each one to determine the number of moles of product. You must solve for **moles** because it is the common denominator. *The reactant that makes the least amount is the limiting reactant and the other is the excess reactant.*

Example: If 5.01g of calcium hydroxide react with 2.2g of potassium bromide, how many moles of calcium bromide will be formed? Identify the limiting and excess reactant.

Step 1: Write the balanced chemical equation.

$$\mathbf{Ca(OH)_2 + 2KBr \rightarrow 2KOH + CaBr_2}$$

Step 2: You are given two "what you know" items, use each one as a separate problem and solve for the **same** product. The one that makes the least is limiting and the one that makes the most is excess.

KNOW: **5.01g $Ca(OH)_2$** **? moles $CaBr_2$**

5.01g $Ca(OH)_2$	1mole $Ca(OH)_2$	1 mole $CaBr_2$	=	**0.06 moles $CaBr_2$**
	74g $Ca(OH)_2$	1 mole $Ca(OH)_2$		

KNOW: **2.2g KBr** **? moles $CaBr_2$**

2.2g KBr	1mole KBr	1 mole $CaBr_2$	=	**0.009 moles $CaBr_2$**
	119g KBr	2 mole KBr		

The KBr is the *limiting* reactant because it makes the *lower* number of moles of product.

Practice Problems:

1) If 6.25g of HCl reacts with 3.4g of $NaHCO_3$, determine how many moles of sodium chloride are produced. Identify the limiting and excess reactants. $HCl + NaHCO_3 \rightarrow NaCl + H_2O + CO_2$

2) 400g of iron reacts with 6 moles of oxygen to form rust (iron III oxide). Determine the moles of rust formed and identify the limiting and excess reactant.

Balanced Equation:____

3) If 3.26 moles of sodium hydroxide react with 9.87 moles of potassium dichromate. Determine the moles of potassium hydroxide and identify the limiting and excess reactant.

Balanced Equation:____

4) 35.42g of magnesium react with 62.34 moles of sulfuric acid. Determine the moles of hydrogen and identify the liming reactant.

Balanced Equation:____

5) 3.2g of barium chloride react with 2.2g of lithium bromide. Determine the moles of lithium chloride and identify the limiting and excess reactants.

Balanced Equation:____

6) 36.95 g of iron II bromide reacts with 3.27 g of potassium phosphate. Determine the moles of potassium bromide and identify the limiting and excess reactants.

Balanced Equation:____

Review Questions

1. What is stoichiometry?

2. What is a mole ratio?

3. What is the difference between a limiting and an excess reactant?

4. What is the formula for percent yield?

5. Suppose the theoretical yield for the product of a chemical reaction is 12.45g NO_2 and a “super scientist” actually collected 12.39g NO_2. Calculate the percent yield for this product.

6. 12.67 moles of aluminum react with 33.54 grams of hydrochloric acid. Determine the moles of hydrogen and identify the limiting and excess reactants.

Balanced Equation:____

Extra Stoichiometry Practice!!

Step 1: Write the balanced equation

Step 2: SET UP YOUR PROBLEM!!!

- What do you know? What are you looking for?

Step 3: Convert grams to moles (if needed)

- Given ALWAYS needs to be in terms of MOLES!

Step 4: Determine mole ratio of given substance to the unknown substance

- Use coefficients in the BALANCED equation
- Place in T-chart so your units would cancel!

Step 5: Convert unknown from moles to grams (if required)

- If required-based on what you are looking for

1) How many grams of magnesium chloride are needed to produce 6.754 grams of magnesium nitrate from a reaction with barium nitrate? **(Answer: 4.29 g)**

2) If 32.4 grams of aluminum react with nitric acid, how many grams of aluminum nitrate are produced? **(Answer: 255.6 g)**

3) Hydrogen gas and oxygen gas react together to make water. If 4.38 g of water vapor are formed, how many moles of oxygen gas was needed in the reaction? **Answer: 0.122 mol)**

4) How many grams of calcium hydroxide will be needed to react completely with 18.52 grams of sulfuric acid? **(Answer: 13.98 g)**

5) How many moles of calcium chloride are produced if you react an excess amount of hydrochloric acid with 7.94 grams of calcium? **(Answer: 0.199 mol)**

6) How many grams of silver chloride are produced when 12.59 grams of silver nitrate are reacted with barium chloride? **(Answer: 10.59 g)**

7) 9.86 moles of calcium hydroxide are reacted with 47.24g of sulfuric acid. Determine the moles of water and identify the limiting and excess reactants. **(Answer:19.72 mol; 0.964 mol; LR = sulfuric acid; ER= calcium hydroxide)**

Unit Learning Map (9 days): Stoichiometry **Mrs. Hostetter**

Class: Chemistry B – PA standard3.4.10A: Explain the relationship between the structure and property of matter.

Unit Essential Question(s):

How can stoichiometry be useful for chemists?

Instructional Tools:

Guided Notes
Lab Materials:
Mole & Mass Relationship lab
Stoichiometry Lab

	Concept 1	Concept 2	Concept 3	Concept 4
Concept:	Stoichiometry	Limiting and Excess Reactants		Reaction Rates
Lesson Essential Question(s):	1) How can you use stoichiometry to solve relationships between reactants and products? 2) How can percent yield be calculated?	1) How can you determine the limiting and excess reactant?		
Vocabulary:	Stoichiometry Mole ratio Law of Conservation of Matter Percent Yield	Limiting reactant Excess reactant		

Stoichiometry Vocabulary:

1) **Stoichiometry** = a quantitative study dealing with relationships between the amounts of reactants and products in a chemical reaction

2) **Mole ratio** = conversion factor that relates the number of moles of any two substances involved in a chemical reaction

3) **Law of Conservation of Matter** = matter cannot be either created or destroyed in ordinary chemical or physical means

4) **Percent yield** = the actual yield of a product as a percentage of the theoretical yield

$$\textbf{Percent yield} = \frac{\textbf{actual yield}}{\textbf{theoretical yield}} \times \textbf{100}$$

5) **Limiting Reactant** = the reactant that limits the amount of the other reactants that can combine, and the amount of products formed in a chemical reaction

6) **Excess Reactant** = the substances that is not used up completely in a reaction

- **Stoichiometry:**
  - Steps:
    1. Write the balanced equation
    2. What do you know? What are you looking for? SET UP YOUR PROBLEM!
    3. Make a T-chart being sure that UNITS CANCEL OUT. Always start the T-chart with your given information!

MASS-MASS Relationship: (convert given mass→moles) (mole ratio) (convert unknown→ g)

MASS-MOLE Relationship: (convert given mass→moles) (mole ratio)

MOLE-MOLE Relationship (given moles) (mole ratio)

*NOTE: Remember when you convert from mass→moles or moles→ mass the conversion factor is **1 mole of a substance equals the molar mass of that substance**!*