Name: _____ Period: ____ Date: _____

**REACTIONS / MOLES / STOICHIOMETRY NOTES**
**HONORS CHEMISTRY**

*Directions: This packet will serve as your notes for this chapter. Follow along with the PowerPoint presentation and fill in the missing information. Important terms / ideas are in all capitals and bolded!*

- **CHEMICAL REACTION**:

  -Changes the way _____ are _____ together

  -Atoms _____ be created or destroyed!

- Indicators of a Reaction

  1) 3)

  2) 4)

- **CHEMICAL EQUATION**:

  -**REACTANTS**:

  -**PRODUCTS**:

  _____ ➔ _____

- Symbols in Equations

| | | |
|---|---|---|
| **Chemical Equation Symbols** | ____ separates the reactants | ____ liquid |
| | ____ separates reactants from products | ____ aqueous or water solution |
| | ____ indicates a reversible reaction | ____ indicates heat is supplied |
| | ____ solid | **CATALYST**: |
| | ____ gas | |

- Rules for Writing Equations

  1) Reactants must be on the _____
  2) Products must be on the _____
  3) Correct _____ (and _____) should be written
  4) An _____ should separate the products from reactants

  -Ex:

*You need to know your Polyatomics for this AND we use Symbols, Charges, Criss-Cross, Simplify (if you can) A LOT!

- Equation Practice

| | |
|---|---|
| **Examples: Write the skeleton equation for each reaction** | ○ Hydrogen (g) + Bromine (g) form _____<br>○ Potassium chlorate breaks down into _____ and _____ |

- Balancing Chemical Equations

  -Since we cannot break the _____, equations MUST be balanced

  -Balanced equations have the _____ of each type of atom on both sides of the equation

  -_____ go in _____ of the formulas so the # of atoms of each element is the same on each side

  WHAT GOES ____ = WHAT COMES _____!

  -**COEFFICIENTS** vs. **SUBSCRIPTS**:

  $2\ H_2\ +\ O_2\ \rightarrow\ 2\ H_2O$

  ***THE ONLY THING YOU ARE ALLOWED TO DO TO BALANCE AN EQUATION IS CHANGE OR ADD COEFFICIENTS!!**

- Equation Examples

| | |
|---|---|
| **Example #1:** | ____ $C$ + ____ $O_2$ → ____ $CO_2$ |
| **Example #2:** | ____ $C$ + ____ $O_2$ → ____ $CO$ |

- Errors to Avoid

  -NEVER change a _____ to balance an equation

  ○ Ex: _____ is a different compound than _____

  -NEVER put a _____ in the middle of a formula

  ○ Ex:

- Best Rule for Balancing…

  **MAKE A _____!!**

  -Show it:

- Balancing Chemical Equations

| | |
|---|---|
| **Example #1:** | ____ $H_2$ + ____ $O_2$ ➔ ____ $H_2O$ |
| **Example #2:** | ____ $AgNO_3$ + ____ $Cu$ ➔ ____ $Cu(NO_3)_2$ + ____ $Ag$<br><br>***IF A POLYATOMIC ION IS PRESENT ON _____ SIDES OF THE EQUATION, IT CAN BE PLACED IN THE TABLE AS A _____ AND NOT BE _____!** |

- Balancing Practice

| Examples | Make a Reactants / Products Table and balance |
|---|---|
| **Example #1:** | _____ + _____ ➔ _____ |
| **Example #2:** | _____ + _____ ➔ _____ |
| **Example #3:** | _____ + _____ ➔ _____ + _____ |

- Types of Reactions

  -_____ of reactions exist… but there are only several categories of reactions

  -We will examine _____ types

| | |
|---|---|
| **SYNTHESIS REACTION**<br><br>***REACTANTS ARE ALWAYS:** | ○ Definition:<br><br>_____ + _____ ➔ _____<br><br>○ Example: _____… Iron plus oxygen produces _____<br><br>○ Example: Predict the products for the reaction and balance. |
| **DECOMPOSITION REACTION**<br><br>***REACTANTS ARE ALWAYS:** | ○ Definition:<br><br>_____ ➔ _____ + _____<br><br>○ Example: _____ decomposes into carbon and water with the help of a _____<br><br>○ Example: Predict the products for the reaction and balance. |
| **SINGLE-REPLACEMENT REACTION**<br><br>***REACTANTS ARE ALWAYS:** | ○ Definition:<br><br>_____ + _____ ➔ _____ + _____<br><br>***METALS REPLACE _____, NONMETALS REPLACE _____!!**<br><br>○ Sometimes it _____!! A must be _____ than B!! |

- **ACTIVITY SERIES (*<u>ONLY</u> USED FOR SINGLE REPLACEMENT!!)**
  - *METALS*: Higher metal (_____) can _____ any metal lower than it, otherwise _____ WILL OCCUR!!
  - *METALS*: Li to Na will _____ H from acids <u>and</u> water… from Mg to Pb will _____ H from _____ only!
  - *NONMETALS*: Higher halogens can _____ any halogen lower than it!! (You must look at your Periodic Table to determine this)

***ONLY FOR <u>METALS</u> (GIVEN THE LIST)**

**Activity Series of Metals**

Decreasing reactivity

| Name | Symbol |
|---|---|
| Lithium | Li |
| Potassium | K |
| Calcium | Ca |
| Sodium | Na |
| Magnesium | Mg |
| Aluminum | Al |
| Zinc | Zn |
| Iron | Fe |
| Lead | Pb |
| (Hydrogen) | (H)* |
| Copper | Cu |
| Mercury | Hg |
| Silver | Ag |

Most Reactive

| | |
|---|---|
| Li | Lithium |
| K | Potassium |
| Ba | Barium |
| Sr | Strontium |
| Ca | Calcium |
| Na | Sodium |
| Mg | Magnesium |
| Al | Aluminum |
| Mn | Manganese |
| Zn | Zinc |
| Cr | Chromium |
| Fe | Iron |
| Cd | Cadmium |
| Co | Cobalt |
| Ni | Nickel |
| Sn | Tin |
| Pb | Lead |
| H | Hydrogen |
| Sb | Antimony |
| As | Arsenic |
| Bi | Bismuth |
| Cu | Copper |
| Hg | Mercury |
| Ag | Silver |
| Pt | Platinum |
| Au | Gold |

Least Reactive

***ONLY FOR <u>NONMETALS</u> (USE YOUR TABLE)**

DECREASING REACTIVITY

F
Cl
Br
I
At

**ONLY IF ___ IS MORE REACTIVE THAN ___!!**

- Example: Many _____ (but not all) will displace _____ with an acid
- Example: Predict the products for the reaction and balance.
- Example: Predict the products for the reaction and balance.

| | |
|---|---|
| **DOUBLE-REPLACEMENT REACTION**<br><br>***REACTANTS ARE ALWAYS:** | ○ Definition:<br><br>_____ + _____ → _____ + _____<br><br>○ Metals in the compound are ALWAYS written _____!!<br><br>○ Sometimes these _____ either! (*FOR THIS UNIT THEY WILL)<br><br>○ Usually involves a _____!! Do NOT look at the Activity Series!<br><br>○ Example: Precipitate is formed from the reaction of two _____ solutions<br><br>○ Example: Predict the products for the reaction and balance. |
| **COMBUSTION REACTION**<br><br>***REACTANTS ARE ALWAYS:** | ○ Definition:<br><br>_____ + _____ → _____ + _____<br><br>○ If the reaction is COMPLETE, the products are always _____ and _____!! If INCOMPLETE, the products are _____ and _____! (*ASSUME COMPLETE)<br><br>○ Example: Burning a _____ in the presence of _____ (very common to us) producing _____<br><br>○ Example: Predict the products for the reaction and balance. |

- Reactions Practice

  -Examples: Determine the type of reaction for each.

  - _____ + _____ →
  - _____ + _____ →
  - _____ + _____ →
  - _____ →
  - _____ + _____ →
  - _____ + _____ →

- Measurement

  -We can measure by mass or volume or we can _____ pieces

  -We measure mass in _____

  -We measure volume in _____

  -We count pieces in numbers, or _____, or _____, or… _____!

- Conversion

  -Mole conversions are useful but not _____ in a lab…

  **1 mole element = _____ (grams)**

  -Get it right from the _____!!

  -For example, 1 mole of arsenic has _____ g

- **MOLAR MASS**:

| **How to Determine Molar Mass:** | 1) Determine the # of _____ of the individual elements that make up the compound (just look at the _____)<br>2) Look up the _____ of each element<br>3) Multiply the _____ of each by the # of _____ of each<br>4) Add up the _____ |
|---|---|

| **Example** | **Calculate the Molar Mass** |
|---|---|
| Find the molar mass of glucose (_____). | |

- Practice

| **Examples** | **Calculate the Molar Mass of Each** |
|---|---|
| | |

| | |
|---|---|
| | |
| | |

- **PERCENT COMPOSITION**:

  -Determine the mass of each _____ and divide each by the total mass of the _____

  -FORMULA:

| **Examples** | **Show all work** |
|---|---|
| Calculate the % composition of a compound that is _____ g of Ag and _____ g of S. | |
| A compound is formed when _____ g Mg combines with _____ g N. What is the % composition? | |
| Calculate the % composition of _____. | |
| What is the % composition of _____? | |

- **MOLE**:

  -When measuring _____ and _____, we use moles

  -Used to count very _____ items

  -Helps convert from the _____ to the _____

  -BUT, WHAT AMOUNT?: _____ "_____"

  -THAT AMOUNT, BUT OF WHAT?

  - **REPRESENTATIVE PARTICLES**:

    Ex:

- Conversions

**1 mole = _____ atoms**

**1 mole = _____ molecules**

**1 mole = _____ formula units**

*YOU NEED TO KNOW THESE!

These can be used in _____ problems!!

- Atoms to Moles

| **Example** | **Show all work, units, and Sig Figs** |
|---|---|
| A sample of Mg has _____ atoms of Mg. How many moles of Mg are contained in the sample? | |

- Practice

| **Example** | **Show all work, units, and Sig Figs** |
|---|---|
| How many atoms are there in _____ moles of Xe? | |
| How many moles of $MgCl_2$ are _____ formula units of $MgCl_2$? | |
| How many molecules of $CO_2$ are there in _____ moles of $CO_2$? | |

- Mole-Mass Relationship

  -Sometimes it is convenient to have measurements in _____ instead of _____

  -We already know that _____ = _____ from the Periodic Table

  -_____ using Dimensional Analysis!

| **Examples** | **Show all work, units, and Sig Figs** |
|---|---|
| How many grams are there in _____ moles of $H_2O$? | |
| How many moles are there in _____ grams of Cu? | |

- Practice

| **Examples** | **Show all work, units, and Sig Figs** |
|---|---|
| How many moles is _____ g NaOH? | |
| How many grams are there in _____ moles of $CO_2$? | |
| How many atoms are there in _____ g of C? | |

- Mole-Volume Relationship

  -Many chemicals exist as _____ but difficult to _____

  -Moles of a gas can be related to volume (_____), but temperature and pressure also play a role

  -**Standard Temp. and Pressure (STP)**:

  -At STP:

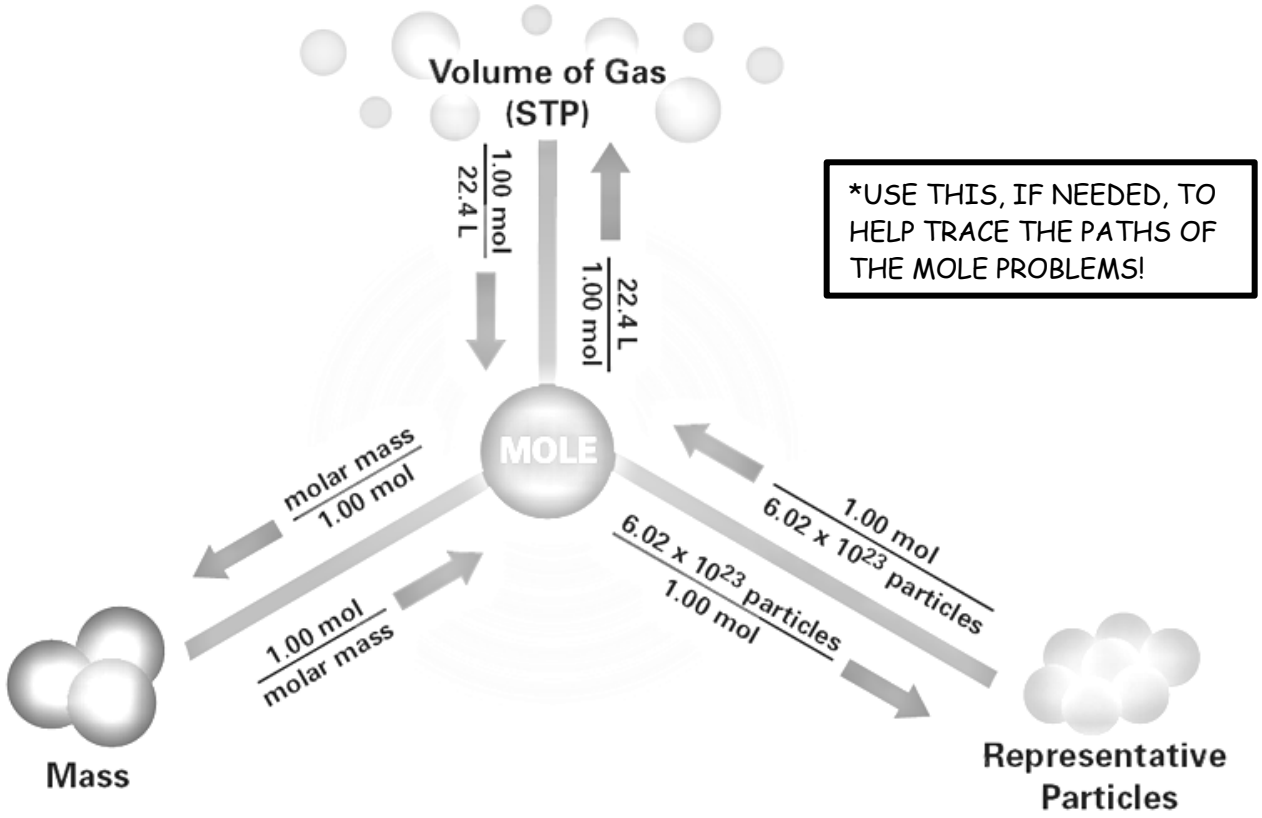
**1 mole gas = _____ liters**

*YOU NEED TO KNOW THIS!

| Examples | Show all work, units, and Sig Figs |
|---|---|
| What is the volume of _____ moles of $CO_2$ at STP? | |
| What is the volume of _____ grams of He at STP? | |

- Practice

| Examples | Show all work, units, and Sig Figs |
|---|---|
| How many moles are _____ L of $O_2$ at STP? | |
| What is the volume of _____ g of $CH_4$ at STP? | |




*USE THIS, IF NEEDED, TO HELP TRACE THE PATHS OF THE MOLE PROBLEMS!

- **EMPIRICAL FORMULA**:

| | |
|---|---|
| **How to Determine Empirical Formula:** | 1) Change the % to _____ (if necessary)<br>2) Convert grams to _____ for <u>each</u> element<br>3) Divide **ALL** of the mole answers by the _____ (mole ratio)<br>4) If all _____, then move on… if not then _____ to get whole #<br>5) Use the whole # to represent the number of each _____… write the formula |

| **Example** | **Show all work** |
|---|---|
| Determine the empirical formula of the following compound: _____% C, _____% O, and _____% Cl. | |

- Practice

| **Examples** | **Show all work** |
|---|---|
| Determine the empirical formula of a compound that is _____% K, _____% C, _____% H, and _____% O. | |
| Methamphetamine is made of _____% C, _____% H, and _____% N. What is its empirical formula? | |

- **MOLECULAR FORMULA**:

| | |
|---|---|
| **How to Determine Molecular Formula:** | 1) Calculate the _____ formula (if needed)<br>2) Calculate the _____ of the empirical formula<br>3) Divide the given _____ molar mass by the _____ molar mass<br>4) Multiply _____ of empirical formula by this #<br>5) Write the molecular formula |

| **Examples** | **Show all work** |
|---|---|
| Determine the molecular formula of a compound composed of _____% C and _____% H with a molar mass of 70 g/mol. | |
| ***COMBUSTION EXAMPLE:** Combustion of 10.68 g of Vitamin C (containing only C, H, and O) yields _____ g of $CO_2$ and _____ g of $H_2O$. The molar mass of the compound is 176.1 g/mol. What are the empirical and molecular formulas of this compound? | |
| A compound is known to be composed of _____% C, _____% H, and _____% Cl. Its molar mass is known to be 197.92 g. What is its molecular formula? | |

- **STOICHIOMETRY**:

  -Balanced equation is much like a _____… tells you the necessary _____, amounts, and the amount of product that will be made

  -Use this information to "_____" the _____ to make how much you want

  -Example: ___ eggs + ___ cups flour + ___ cup sugar + ___ cups milk ➔ ___ cookies

  I need ___ eggs for every ___ cookies

  I need ___ cups flour for every ___ sugar

  I need ___ cups milk for every ___ cookies

  **There's a _____ for each ingredient and product!**

  -Example: ___ $H_2$ + ___$O_2$ ➔ ___ $H_2O$

  I need ___ $H_2$ for every ___ $O_2$

  I need ___ $H_2O$ for every ___ $O_2$

  I need ___ $H_2$ for every ___ $H_2O$

  **There's a _____ for each reactant and product… _____!!**

- Balanced Equations

  -Coefficients in a balanced chemical equation can represent a ratio of _____, molecules, _____(gases), or _____… NOT _____!

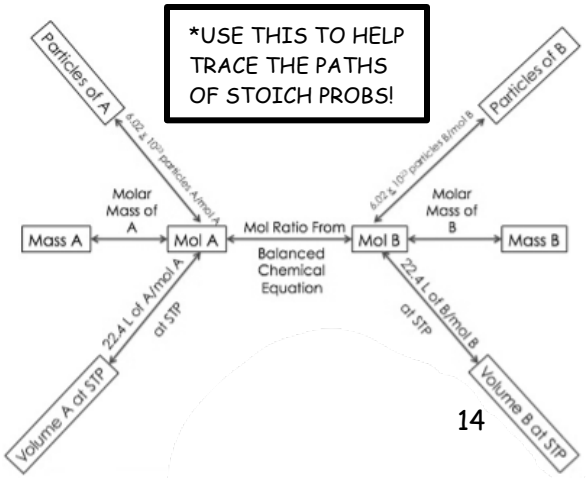
  -Convert from an amount of one _____ to another or to amounts of _____

  -Use _____

  **Equations must be _____ and _____ in order to do these problems!!**

- Stoichiometry Problems

  **-Always follow this same basic format…**



- Mole to Mole Conversions

| **Examples** | **Show all work, units, and Sig Figs** |
|---|---|
| Sodium and chlorine gas react to produce sodium chloride. How many moles of sodium chloride can be produced from _____ moles of sodium? | |
| How many moles of $O_2$ are produced when _____ moles of aluminum oxide decompose? | |

- Mass to Mass Conversions

| **Examples** | **Show all work, units, and Sig Figs** |
|---|---|
| If _____ g of Fe (3+) are added to a solution of copper (II) sulfate, how much solid copper would form? | |
| Silicon computer chips are made using the reaction given. How many grams of Mg are needed to make _____ g of Si? | $SiCl_4 + 2\ Mg \rightarrow 2\ MgCl_2 + Si$ |

- Mass to Volume Conversions

| **Examples** | **Show all work, units, and Sig Figs** |
|---|---|
| Potassium metal reacts with water to produce potassium hydroxide and hydrogen gas. If _____ g K is reacted completely, how many liters of $H_2$ gas can be produced at STP? | |

| | |
|---|---|
| In order to combust _____ moles of $C_2H_2$, how many moles of $O_2$ are required? Balance the equation. | ____ $C_2H_2$ + ____ $O_2$ ➔ ____ $CO_2$ + ____ $H_2O$ |
| Sodium and chlorine gas react to give sodium chloride. If you end up with _____ g of NaCl, how many grams of Na did you start with? | |
| If Mg and _____ L of HCl gas are reacted, how many grams of $MgCl_2$ are formed? | |

- Limiting vs. Excess Reagent

| LIMITING REAGENT | EXCESS REAGENT |
|---|---|
| | |

-Amount of reactants available for a reaction _____ the amount of product that can be made

-To determine the limiting reagent, you must do at least ____ stoich problems with the reactants

-Reactant that makes the _____ amount of _____ is the limiting reagent!!!
**(*NEVER reach the higher amount because the reaction would STOP at the lower amount!)**

- Limiting Reagent Problems

| | |
|---|---|
| **How to Determine Limiting Reagent:** | 1) Convert to _____ for each of the givens (remember <u>two</u> problems!)<br>2) Use the _____ to convert to moles of the product<br>3) Keep going to _____ of the product (could just compare moles, but usually the question asks you this anyway)<br>4) Reactant that produces the _____ product is the limiting reactant |

| Limiting Example | Show all work, units, and Sig Figs |
|---|---|
| Copper reacts with sulfur to form copper (I) sulfide. If _____ g of Cu reacts with _____ g S, how much product will be formed? | |

- Excess Reagent Problems

| Steps for an Excess Reagent Problem: | 1) Start with the _____<br>2) Use stoich to go to grams of the _____<br>3) _____ from the <u>original amount</u> of the excess |
|---|---|

| Excess Example | Show all work, units, and Sig Figs |
|---|---|
| How much of the _____ reagent will be left over from the previous problem? | |

- Practice

| Example | Show all work, units, and Sig Figs |
|---|---|
| Identify the limiting reagent and how much ammonia gas can be produced when ____ g of nitrogen gas reacts with ____ g of hydrogen gas.<br><br>How many _____ of excess reagent are left over from the previous problem? | |

| Example | Show all work, units, and Sig Figs |
|---|---|
| Using the equation given, identify the limiting reagent when _____ g HCl reacts with _____ g Mg. How much $MgCl_2$ will form? | $Mg + 2\ HCl \rightarrow MgCl_2 + H_2$ |

- **PERCENT YIELD**:

  -No one is _____ in the laboratory… used to figure out how _____ the methods were

| | |
|---|---|
| **ACTUAL YIELD:** | |
| **THEORETICAL YIELD:** | |

  -EQUATION TO FIND:

| | |
|---|---|
| **How to Determine Percent Yield:** | 1) _____ is given or found in lab<br>2) Calculate _____ by dimensional analysis (may need limiting reagent)<br>3) Use the _____<br>***SHOULD _____ BE GREATER THAN _____... WHY?** |

| Example | Show all work |
|---|---|
| A group of students determined that they should get _____ g of product from a reaction. They actually ended up with _____ g. What is their percent yield? | |

- Practice

| Example | Show all work, units, and Sig Figs |
|---|---|
| About _____ g of aluminum are reacted with _____ g of copper (II) sulfate producing aluminum sulfate and copper. If _____ g of copper are produced, what is the percent yield? | |