# Name: 

$\qquad$ Date: $\qquad$
Chemistry ~Ms. Hart
Class: Anions or
Cations

### 6.6 The Mole

| 1. $\qquad$ Mg + $\qquad$ $\mathrm{O}_{2} \rightarrow$ $\qquad$ MgO <br> What kind of reaction is this? | How many moles of $\mathrm{Mg}, \mathrm{O}_{2}$, and MgO are there? $\begin{aligned} & \mathrm{Mg} \\ & \mathrm{O}_{2} \\ & \mathrm{MgO} \\ & \hline \end{aligned}$ | What is the mole ratio of $\mathrm{Mg}: \mathrm{MgO}$ ? <br> What is the mole ratio of $\mathrm{O}_{2}: \mathrm{Mg}$ ? |
| :---: | :---: | :---: |
| 2. $\qquad$ $\mathrm{Sb}+$ $\qquad$ $\mathrm{Cl}_{2} \rightarrow$ $\qquad$ $\mathrm{SbCl}_{3}$ <br> What kind of reaction is this? | How many moles of <br> Sb $\qquad$ <br> $\mathrm{Cl}_{2}$ $\qquad$ <br> $\mathrm{SbCl}_{3}$ $\qquad$ | What is the mole ratio of $\mathrm{Sb}: \mathrm{Cl}_{2}$ ? |
| 3. $\qquad$ $\mathrm{NaBr}+$ $\qquad$ $\mathrm{Cl}_{2} \rightarrow$ $\qquad$ $\mathrm{NaCl}+$ $\qquad$ $\mathrm{Br}_{2}$ <br> What kind of reaction is this? | How many moles of $\begin{aligned} & \mathrm{NaBr} \\ & \mathrm{Cl}_{2} \\ & \mathrm{NaCl} \\ & \mathrm{Br}_{2} \\ & \hline \end{aligned}$ | What is the mole ratio of NaBr : $\mathrm{Br}_{2}$ ? <br> What is the mole ratio of $\mathrm{Br}_{2}$ : NaBr ? |
| 4. $\qquad$ $\mathrm{NaClO}_{3} \rightarrow$ $\qquad$ $\mathrm{NaCl}+$ $\qquad$ $\mathrm{O}_{2}$ <br> What kind of reaction is this? | How many moles of $\mathrm{NaClO}_{3}$ $\qquad$ <br> NaCl $\qquad$ <br> $\mathrm{O}_{2}$ $\qquad$ | What is the mole ratio of $\mathrm{NaCl}: \mathrm{NaClO}_{3}$ ? |
| $\text { 5. } \_\ldots \ldots \mathrm{Fe}+\ldots \mathrm{HCl} \rightarrow \ldots \mathrm{FeCl}_{2}+\ldots \mathrm{H}_{2}$ | How many moles of Fe $\qquad$ <br> HCl $\qquad$ | What is the mole ratio of $\mathrm{Fe}: \mathrm{FeCl}_{2}$ ? |


| What kind of reaction is this? | $\begin{aligned} & \mathrm{FeCl}_{2} \\ & \mathrm{H}_{2} \\ & \hline \end{aligned}$ |  |
| :---: | :---: | :---: |
| 6. $\qquad$ $\mathrm{N}_{2}+$ $\qquad$ $\mathrm{O}_{2} \rightarrow$ $\qquad$ $\mathrm{N}_{2} \mathrm{O}_{5}$ <br> What kind of reaction is this? | How many moles of $\mathrm{N}_{2}$ $\qquad$ <br> $\mathrm{O}_{2}$ $\qquad$ $\mathrm{N}_{2} \mathrm{O}_{5}$ $\qquad$ | What is the mole ratio of $\mathrm{N}_{2} \mathrm{O}_{5}: \mathrm{N}_{2}$ ? |
| 7. $\qquad$ $\mathrm{MgCO}_{3} \rightarrow$ $\qquad$ $\mathrm{MgO}+$ $\qquad$ $\mathrm{CO}_{2}$ <br> What kind of reaction is this? | How many moles of $\mathrm{MgCO}_{3}$ <br> MgO $\qquad$ <br> $\mathrm{CO}_{2}$ $\qquad$ | What is the mole ratio of $\mathrm{MgO}: \mathrm{CO}_{2}$ ? <br> What is the mole ratio of $\mathrm{CO}_{2}: \mathrm{MgO}$ ? |
| 8. <br> What kind of reaction is this? | How many moles of $\mathrm{MgBr}_{2}$ $\qquad$ <br> $\mathrm{Cl}_{2}$ $\qquad$ <br> $\mathrm{MgCl}_{2}$ $\qquad$ <br> $\mathrm{Br}_{2}$ $\qquad$ | What is the mole ratio of $\mathrm{MgBr}_{2}: \mathrm{MgCl}_{2}$ ? |
| 9.- <br> Zn + $\qquad$ $\mathrm{CuSO}_{4} \rightarrow$ $\qquad$ $\mathrm{Cu}+$ $\qquad$ $\mathrm{ZnSO}_{4}$ <br> What kind of reaction is this? | How many moles of <br> Zn $\qquad$ <br> $\mathrm{CuSO}_{4}$ $\qquad$ <br> Cu $\qquad$ $\mathrm{ZnSO}_{4}$ $\qquad$ | What is the mole ratio of $\mathrm{Cu}: \mathrm{Zn}$ ? |
| 10. $\qquad$ $\mathrm{NH}_{4} \mathrm{NO} 2 \rightarrow$ $\qquad$ $\mathrm{N} 2+$ $\qquad$ H 2 O <br> What kind of reaction is this? | How many moles of $\mathrm{NH}_{4} \mathrm{NO} 2$ $\qquad$ <br> N2 $\qquad$ <br> H 2 O $\qquad$ | What is the mole ratio of $\mathrm{H} 2 \mathrm{O}: \mathrm{NH} 4 \mathrm{NO} 2$ ? |

## Stoichiometry Part I: Mole to Mole

## Example 1:

Using the chemical equation below:
$2 \mathrm{Al}+3 \mathrm{CuSO}_{4} \rightarrow \mathrm{Al}_{2}\left(\mathrm{SO}_{4}\right)_{3}+3 \mathrm{Cu}$
What is the number of moles of Al needed if 9 moles of Cu is produced?
Step 1. Write the given (include units!). Given= $\qquad$
Step 2. What are we looking for (include units!) Want to know: $\qquad$
Step 3. What is the mole-to-mole ratio between the given and the compound we are looking for?

Step 4: List the given first and then multiply it by the ratio we found in step 3 so that the unit for what we want to know is the only factor left over.

## Example 2:

Using the chemical equation below:

$$
4 \mathrm{Fe}(\mathrm{~s})+3 \mathrm{O}_{2}(\mathrm{~g}) \rightarrow 2 \mathrm{Fe}_{2} \mathrm{O}_{3}(\mathrm{~s})
$$

If 10 moles of Fe is used, how many moles of $\mathrm{Fe}_{2} \mathrm{O}_{3}$ is produced?

Step 1. Write the given (include units!). Given= $\qquad$
Step 2. What are we looking for (include units!) Want to know: $\qquad$
Step 3. What is the mole-to-mole ratio between the given and the compound we are looking for?

Step 4: List the given first and then multiply it by the ratio we found in step 3 so that the unit for what we want to know is the only factor left over.

## Example 3:

Using the chemical equation below:
$\mathrm{N}_{2} \mathrm{O}_{5}+\mathrm{H}_{2} \mathrm{O} \rightarrow 2 \mathrm{HNO}_{3}$
How many moles of $\mathrm{HNO}_{3}$ is produced if 17 moles of $\mathrm{H}_{2} \mathrm{O}$ is reacted?

## Example 4:

Given the reaction: $\mathrm{Ca}+2 \mathrm{H}_{2} \mathrm{O} \rightarrow \mathrm{Ca}(\mathrm{OH})_{2}+\mathrm{H}_{2}$
What is the total number of moles of Ca needed to react completely with 4.0 moles of $\mathrm{H}_{2} \mathrm{O}$ ?
(1) 1.0
(2) 2.0
(3) 0.50
(4) 4.0

## Practice Part I: Mole-to-mole conversion (complete on loose leaf!)

1. Determine the number of moles of Ca produced when you start with 3 moles of $\mathrm{CaCl}_{2}$ in the chemical reaction: $\mathrm{CaCl}_{2} \rightarrow \mathrm{Ca}+\mathrm{Cl}_{2}$
2. Determine the number of moles of MgO produced when you start with 4 moles of Mg in the chemical reaction: $2 \mathrm{Mg}+\mathrm{O}_{2} \rightarrow 2 \mathrm{MgO}$
3. Determine the number of moles of MgO produced when you start with 5 moles of $\mathrm{O}_{2}$ in the chemical reaction: $2 \mathrm{Mg}+\mathrm{O}_{2} \rightarrow 2 \mathrm{MgO}$.
4. Some dry chemicals can be used to put out forest fires. One of these chemicals is $\mathrm{NaHCO}_{3}$. When $\mathrm{NaHCO}_{3}(\mathrm{~s})$ is heated, one of the products is $\mathrm{CO}_{2}(\mathrm{~g})$, as shown in the balanced equation below.
$2 \mathrm{NaHCO}_{3}+$ heat $\rightarrow \mathrm{Na}_{2} \mathrm{CO}_{3}(\mathrm{~s})+\mathrm{H}_{2} \mathrm{O}(\mathrm{g})+\mathrm{CO}_{2}(\mathrm{~g})$
a) Show the correct numerical setup for calculating the percent composition by mass of carbon in the product $\mathrm{Na}_{2} \mathrm{CO}_{3}$.
b) Determine the total number of moles of $\mathrm{CO}_{2}(\mathrm{~g})$ produced when 7.0 moles of $\mathrm{NaHCO}_{3}(\mathrm{~s})$ is completely reacted.

## Stoichiometry Part II: Moles - Grams!

## Example 1:

What is the mass of 4.76 moles of $\mathrm{Na}_{3} \mathrm{PO}_{4}$ (gram-formula mass $=164 \mathrm{grams} / \mathrm{mole}$ )?
Step 1. List the given. (Write units!) Given = $\qquad$
Step 2. Determine what we need to find. (Write units!) Need to find = $\qquad$
Step 3. Calculate the gram formula mass of the molecule that we are dealing with.
Well... in this case, we already have it: Gram formula mass of $\qquad$ $=$

Step 4. Set up by listing the given first and multiply it the gram-formula mass we found in step 3 so that the unit for what we want to know is the only factor left over.

## Example 2:

What is the mass of 5.36 moles of $\mathrm{H}_{2} \mathrm{O}$ ?
Step 1. List the given. (Write units!)
Given $=$ $\qquad$
Step 2. Determine what we need to find. (Write units!) Need to find = $\qquad$
Step 3. Calculate the gram formula mass of the molecule that we are dealing with.
$\qquad$ $=$

Step 4. Set up by listing the given first and multiply it the gram-formula mass we found in step 3 so that the unit for what we want to know is the only factor left over.

## Stoichiometry Part III: Gram-to-mole conversions

- We can convert from gram-to-mole using the same method.


## Example 1:

Determine the total number of moles of $\mathrm{CH}_{3} \mathrm{Br}$ in 19 grams of $\mathrm{CH}_{3} \mathrm{Br}$ (gram-formula mass $=95$ grams $/ \mathrm{mol}$ ).

Step 1. List the given. (Write units!) Given = $\qquad$
Step 2. Determine what we need to find. (Write units!) Need to find $=$ $\qquad$
Step 3. Calculate the gram formula mass of the molecule that we are dealing with.
Well... in this case, we already have it: Gram formula mass of $\qquad$ $=$

Step 4. Set up by listing the given first and multiply it by the gram-formula mass we found in step 3 so that the unit for what we want to know is the only factor left over.

## Example 2:

What is the total number of moles in 80.0 grams of $\mathrm{C}_{2} \mathrm{H}_{5} \mathrm{Cl}$ (gram-formula mass $=64.5 \mathrm{grams} / \mathrm{mol}$ ).
Step 1. List the given. (Write units!)
Given $=$ $\qquad$
Step 2. Determine what we need to find. (Write units!) Need to find $=$ $\qquad$
Step 3. Calculate the gram formula mass of the molecule that we are dealing with.
$\qquad$ $=$

Step 4. Set up by listing the given first and multiply it by the gram-formula mass we found in step 3 so that the unit for what we want to know is the only factor left over.

## Part II: Mole-to-gram Conversions Practice!

5. What is the mass of 4 moles of Li?
6. Approximately how many grams of HCl do you have if there are 3 moles of HCl ?
7. Approximately how many grams of $\mathrm{H}_{2} \mathrm{SO}_{4}$ do you have if there are 2 moles of $\mathrm{H}_{2} \mathrm{SO}_{4}$ ?

## Part III: Gram-to-mole conversion

8. Approximately how many moles of Na do you have if there are 69 grams of Na ?
9. Approximately how many moles of KCl do you have if there are 150 grams of KCl ?
10. Approximately how many moles of $\mathrm{H}_{2} \mathrm{SO}_{4}$ do you have if there are 392 grams of $\mathrm{H}_{2} \mathrm{SO}_{4}$ ?

## Additional Practice/Homework:

1. According to the reaction $2 \mathrm{Al}+3 \mathrm{H}_{2} \mathrm{SO}_{4} \rightarrow 3 \mathrm{H}_{2}+\mathrm{Al}_{2}\left(\mathrm{SO}_{4}\right)_{3}$, the total number of moles of $\mathrm{H}_{2} \mathrm{SO}_{4}$ needed to react completely with 5 mol of Al is
(1) 2.5 mol
(2) 5 mol
(3) 7.5 mol
(4) 9 mol
2. Given the equation $\mathrm{N}_{2}+3 \mathrm{H}_{2} \rightarrow 2 \mathrm{NH}_{3}$, what is the total number of moles of $\mathrm{NH}_{3}$ produced when 10 mol of $\mathrm{H}_{2}$ reacts completely with $\mathrm{N}_{2}$ ?
(1) 2 mol
(2) 3 mol
(3) 6.7 mol
(4) 15 mol
3. The process of photosynthesis can be represented by the following equation, $6 \mathrm{CO}_{2}+6 \mathrm{H}_{2} \mathrm{O}+$ energy $\rightarrow \mathrm{C}_{6} \mathrm{H}_{12} \mathrm{O}_{6}+6 \mathrm{O}_{2}$
If 4 mol of $\mathrm{C}_{6} \mathrm{H}_{12} \mathrm{O}_{6}$ is produced by the process, how many moles of $\mathrm{CO}_{2}$ and $\mathrm{H}_{2} \mathrm{O}$ were used?
4. Given the equation $\mathrm{Mg}+2 \mathrm{HCl} \rightarrow \mathrm{MgCl}_{2}+\mathrm{H}_{2}$, how many moles of HCl are needed to react with 0.5 mol of magnesium?
(1) 0.5 mol
(2) 1 mol
(3) 2 mol
(4) 4 mol
5. Consider the following equation: $\quad 2 \mathrm{C}_{2} \mathrm{H}_{6}+\mathrm{O}_{2} \rightarrow 4 \mathrm{CO}_{2}+6 \mathrm{H}_{2} \mathrm{O}$

When 4 mol of $\mathrm{C}_{2} \mathrm{H}_{6}$ are burned the number of moles of $\mathrm{CO}_{2}$ produced will be
(1) 2 mol
(2) 6 mol
(3) 7 mol
(4) 8 mol

