

## **LESSON 10.1: Intro to Moles & Molar Mass**

**Stoichiometry**

**Chemical Formulas Review**

**The Mole**

## Guided Notes: Unit 10 – Moles/Stoichiometry (Honors)

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### **Gram Atomic Mass (G.A.M.)**

#### **Examples:**

1. What is the molar mass of iron?
2. What is the molar mass of copper?
3. What is the molar mass of chlorine?

### **Gram Formula Mass aka Molar Mass (G.F.M.)**

#### **Steps for Calculating GFM:**

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### Examples:

1. What is the molar mass of water?
2. What is the gram-formula-mass of calcium chloride?

### YOU DO Practice:

1. MgO
2. BaF<sub>2</sub>
3. Na<sub>2</sub>S
4. Cu(OH)<sub>2</sub>
5. Al<sub>2</sub>O<sub>3</sub>
6. Mn(NO<sub>3</sub>)<sub>3</sub>
7. (NH<sub>4</sub>)<sub>2</sub>CO<sub>3</sub>
8. Fe<sub>3</sub>(PO<sub>4</sub>)<sub>2</sub>

## LESSON 10.2: Calculating Moles

## Guided Notes: Unit 10 – Moles/Stoichiometry (Honors)

### Simple Mole Conversions (mass ↔ moles):

#### Mole Calculations

$$\text{number of moles} = \frac{\text{given mass}}{\text{gram-formula mass}}$$

### Mass (grams) to Moles

1. How many moles are in 39.0 grams of LiF?
2. What is the number of moles of potassium chloride present in 148 grams of the substance?

### Moles to Mass (grams)

1. What is the mass of 4.5 moles of KOH?
2. What is the mass of 0.5 moles of CuSO<sub>4</sub>?

Used for all mole-mass-particle calculations

# The Mole Bridge

## Guided Notes: Unit 10 – Moles/Stoichiometry (Honors)

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### Mole Bridge Rules

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### **WE Do Problems:**

1. Calculate the number of moles in 589 grams of iodine.
2. How many particles are in 257 grams of  $\text{NH}_4\text{Cl}$ ?
3. What is the mass of 3.65 mol of Potassium Permanganate?
4. Calculate the number of grams in  $9.03 \times 10^{23}$  molecules of sodium oxide,  $\text{Na}_2\text{O}$ .
5. What is the volume of 285 g of Ammonium Nitrate?

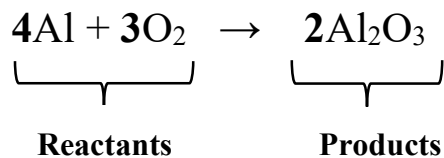
### **YOU Do Problems:**

## Guided Notes: Unit 10 – Moles/Stoichiometry (Honors)

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- 1) How many moles are in 15 grams of lithium?
- 2) How many grams are in 4.5 moles of NaF?
- 3) How many particles are in 450 grams of  $\text{Cu}(\text{OH})_2$ ?
- 4) What is the volume of 0.5 moles of methane gas,  $\text{CH}_4$ , at STP?
- 5) How many moles are in 68 grams of  $\text{Cu}(\text{OH})_2$ ?
- 6) What is the mass of 0.2 moles of Sodium Hydroxide
- 7) Calculate the number of grams in  $9.03 \times 10^{23}$  molecules of magnesium sulfide,  $\text{Mg}_2\text{S}$
- 8) Calculate the number of moles in 100 liters of carbon dioxide gas.

## LESSON 10.3: Mole Ratios/Stoichiometry



Coefficients:

Subscripts:

Moles of Atoms

Examples:

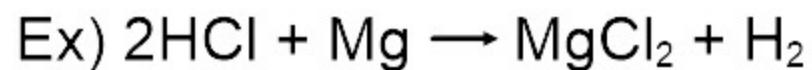
- 1) How many moles of Al atoms are in 1 mole of  $\text{Al}_2\text{O}_3$ ?
- 2) How many moles of O atoms are in 1 mole of  $\text{Mg}_3(\text{PO}_4)_2$ ?
- 3) How many moles of atoms are in 1 mole of  $\text{Ca}(\text{OH})_2$ ?



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### Mole Ratios:



- 1) What is the mole to mole ratio of HCl to Mg?
- 2) What is the mole to mole ratio of Mg to MgCl<sub>2</sub>?
- 3) How many moles of Mg would be required to react with 1 mole of HCl?
- 4) How many moles of hydrogen are produced when 4 moles of HCl react with excess Mg?

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### Calculating Mole Ratios:

#### **Lets Try It...**

- 1) Balance
- 2) What is the mole ratio of NaCl to Cl<sub>2</sub>?
  
- 3) How many moles of Cl<sub>2</sub> would be required to react with 6.00 moles of NaCl?

#### **WE DO:**

**Example #1:** How many moles of oxygen are consumed when 0.6 moles of hydrogen burns to produce water?

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**Example #2:** How many moles of nitrogen gas ( $\text{N}_2$ ) would be needed to produce 10 moles of ammonia ( $\text{NH}_3$ ) in the following rxn?

**Example #3:** If 12 moles of  $\text{C}_3\text{H}_8$  react completely, how many moles of  $\text{H}_2\text{O}$  are formed in the reaction below?

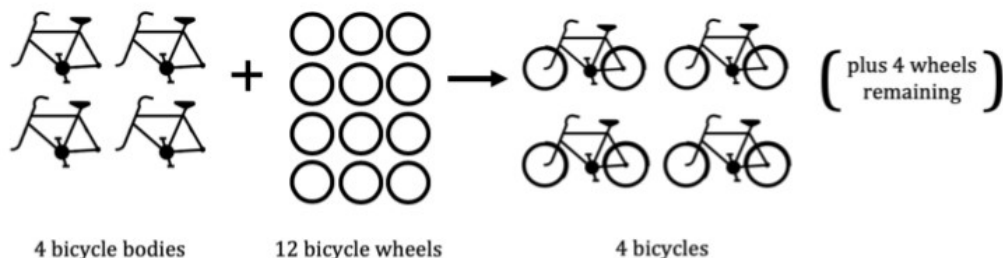
### YOU DO:

- 1) What is the mass of 10.5 moles of diatomic oxygen?
- 2) Calculate the number of moles in 560 grams of bromine.
- 3) Calculate the number of atoms in 8.1 moles of sodium.

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**LESSON 10.4: Limiting Reactant (Reagent) Problems****What is a Limiting Reactant?**

- **Limiting Reactant** - The reactant in a chemical reaction that is completely used up during the reaction. This chemical limits the amount of product that can be formed.
- **Excess Reactant** - The reactant in a chemical reaction that remains after a reaction ends.

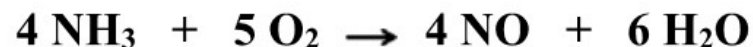


Which is the **limiting reactant** in the example above? bicycle bodies

Which is the **excess reactant** in the example above? bicycle wheels

**Example:**

A 2.00 g sample of ammonia is mixed with 4.00 g of oxygen. Which is the limiting reactant?



- **Note:** Choose a product, and then convert both reactants into grams of that product. It does not matter which product is chosen, but the same product must be used both times.

$$\frac{2.00 \text{ g NH}_3}{1} \times \frac{1 \text{ mole NH}_3}{17.03 \text{ g NH}_3} \times \frac{6 \text{ moles H}_2\text{O}}{4 \text{ moles NH}_3} \times \frac{18.02 \text{ g H}_2\text{O}}{1 \text{ mole H}_2\text{O}} = 3.17 \text{ g H}_2\text{O}$$

$$\frac{4.00 \text{ g O}_2}{1} \times \frac{1 \text{ mole O}_2}{32.00 \text{ g O}_2} \times \frac{6 \text{ moles H}_2\text{O}}{5 \text{ moles O}_2} \times \frac{18.02 \text{ g H}_2\text{O}}{1 \text{ mole H}_2\text{O}} = 2.70 \text{ g H}_2\text{O}$$

(The excess reactant is  $\text{NH}_3$  because there will still be some left over after the reaction)

**Answer:** The limiting reactant is  $\text{O}_2$  because it produces the least amount of product and will be entirely used up during the reaction.

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### WE DO Practice Problems:

- 1) During an experiment, 3.25 g of  $\text{NH}_3$  reacts with 3.50 g of  $\text{O}_2$ . What is the limiting reactant?



- 2) If 4.95 g of ethylene ( $\text{C}_2\text{H}_4$ ) are combusted with 3.25 g of oxygen, what is the limiting reactant?



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3) Consider the reaction of  $\text{C}_6\text{H}_6 + \text{Br}_2 \rightarrow \text{C}_6\text{H}_5\text{Br} + \text{HBr}$

What is the limiting reactant if 42.1 g of  $\text{C}_6\text{H}_6$  reacts with 73.0 g of  $\text{Br}_2$ ?

4) Consider the following reaction:  $2 \text{Al} + 6 \text{HBr} \rightarrow 2 \text{AlBr}_3 + 3 \text{H}_2$

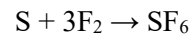
When 73.22 grams of Al reacts with 54.96 grams of HBr, what is the limiting reactant?

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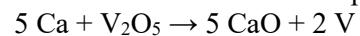
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### YOU DO Practice Problems:

1. Suppose you have 4 moles of sulfur and 3 moles of fluorine, which is the limiter and which is in excess? How many moles of SF<sub>6</sub> can be produced?



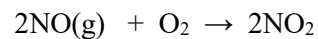
2. If 10 moles of calcium react with 3 moles of V<sub>2</sub>O<sub>5</sub>. Find the limiter and the amount of V produced.



## Guided Notes: Unit 10 – Moles/Stoichiometry (Honors)

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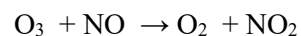
3. Nitric oxide (NO) reacts with oxygen gas to form nitrogen dioxide (NO<sub>2</sub>), a dark brown gas:



In one experiment 0.866 mol of NO is mixed with 0.503 mol of O<sub>2</sub>

- Determine the limiting reagent
- Calculate the number of moles of NO<sub>2</sub> produced

4. The depletion of ozone (O<sub>3</sub>) in the stratosphere has been a matter of great concern among scientists in recent years. It is believed that ozone can react with nitric oxide (NO) that is discharged from high altitude planes. The reaction is



If 7.40 g of O<sub>3</sub> reacts with 0.670 g of NO,

- Which compound will be the limiting reagent?
- How many grams of NO<sub>2</sub> will be produced?
- Calculate the number of moles of the excess reagent remaining at the end of the reaction.



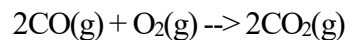
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$$\% \text{ yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100\%$$

### Theoretical & Percent Yield

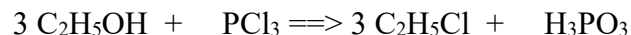
#### Percent Yield for “Regular” Stoichiometry Problems

Ex 1) Calculate the % yield if 69.1g of CO combines with excess O<sub>2</sub> to form an experimental yield of 48.3L of CO<sub>2</sub> @STP



#### Percent Yield for “Limiting” Stoichiometry Problems

Ex 1) Calculate the theoretical yield of C<sub>2</sub>H<sub>5</sub>Cl if 112 g of C<sub>2</sub>H<sub>5</sub>OH is reacted with 34.7g of PCl<sub>3</sub> based on the reaction below. If 23.7 g of C<sub>2</sub>H<sub>5</sub>Cl is produced, what is the percent yield?



Ex 2) 1.80 g H<sub>2</sub> is allowed to react with 9.79 g N<sub>2</sub>, producing 2.02 g NH<sub>3</sub>.

What is the theoretical yield and the percent yield for this reaction under the given conditions? (Write a balanced equation)

## LESSON 10.5: Percent Composition

Percent Composition (formula on Table T):

**Percent Composition**

$$\% \text{ composition by mass} = \frac{\text{mass of part}}{\text{mass of whole}} \times 100$$

Calculating Percent Composition:

**WE DO:**

**Example #1:** What is the percent composition of Calcium in Calcium Chloride?

**Example #2:** What is the percent composition of Nitrogen in Ammonium Phosphate?

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### **YOU DO:**

1) What percent of Magnesium Bromide is Magnesium?

2) What percentage of Glucose is Carbon?

3) What percent of Zinc Phosphate is Zinc?

## Guided Notes: Unit 10 – Moles/Stoichiometry (Honors)

### Percent Composition of a Hydrate



$$\underline{\text{Mass of water} = \text{Mass of Hydrate} - \text{Mass of Anhydrate}}$$

How does water get trapped in crystal?

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### Calculating % Composition of a Hydrate:

#### WE DO:

Ex 1) What is the percentage by mass of water in sodium carbonate crystals ( $\text{Na}_2\text{CO}_3 \cdot 10 \text{H}_2\text{O}$ )?

Ex 2) What is the percent by mass of water in  $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$ ?

Ex 3) A student heats a hydrate until the mass remains constant.

The student records the following data:

The student records the following data:

Mass of hydrate before heating: 4.65 g

Mass of the hydrate after heating: 3.09 g

a. What was the mass of the water lost during heating?

b. What was the percent by mass of water in the hydrate before heating?

## LESSON 10.6: Determining Empirical & Molecular Formula

### Types of Chemical Formulas:

To check to see if molecules have the same empirical formula, simply reduce the subscripts.

	<b>Molecular</b>	<b>Empirical</b>
ex:	$C_6H_{12}O_6$	
	$C_{11}H_{22}O_{11}$	
	$CH_4$	
	$C_2H_8$	
	$C_3H_{12}$	

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### Empirical Formulas:

#### Examples:

1.  $C_6H_{12}O_6$
2.  $N_2O_4$
3.  $BaCl_2$
4.  $C_2H_6$
5.  $CH_3$
6. What is the empirical formula of a compound composed of 21.1 moles of Zinc, 42.2 moles of Nitrogen, and 126.6 moles of Oxygen?
7. What is the empirical formula of a compound composed of 92.24% Carbon and 7.76% Hydrogen

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### Molecular Formulas:

#### WE DO Examples:

1. What is the molecular formula of a compound that has an empirical formula of  $\text{NO}_2$  and molecular mass of 92.0 g?
  
  
  
  
  
  
  
  
  
  
2. The empirical formula for ethylene is  $\text{CH}_2$ . Find the molecular formula if the molecular mass is 28.1 g/mol?