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## Unit 10: Stoichiometry

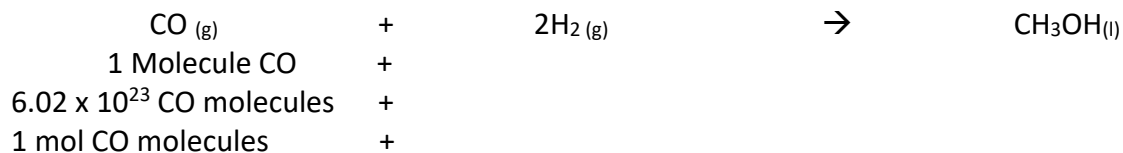
Stoichiometry= the process of using a \_\_\_\_\_  
to determine the relative amounts of reactants and products involved in a reaction.

Info given by a chemical equation:

- Chemical changes involve the \_\_\_\_\_ of atom groupings as one or more substances change to new substances
- Reactants vs. products

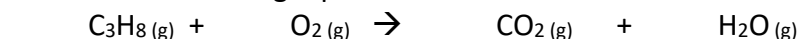
What info are we given by the following equation?

- The \_\_\_\_\_ can be used to describe the reaction
- The coefficients can have units of \_\_\_\_\_ or \_\_\_\_\_

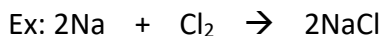


Balancing Equations- first step in all stoichiometry problems is to balance the equation.

Balance the following equation:



Mole Ratio= the ratio of moles of one substance to moles of another substance in a balanced chemical equation. Mole ratios are determined from the coefficients in a balanced chemical equation. Mole ratios are used as conversion factors in stoichiometry.



Mole ratio of sodium to chlorine gas= \_\_\_\_\_

Mole ratio of sodium to sodium chloride= \_\_\_\_\_

Mole ratio of chlorine to sodium chloride= \_\_\_\_\_

Why is a BALANCED chemical equation important?

### Mole to Mole relationships

- We can use a \_\_\_\_\_ chemical equation to predict the moles of products that a given number of moles of reactant will yield, or moles of reactant needed for a certain amount of product
- \_\_\_\_\_ are used instead of \_\_\_\_\_ because each element/compound has a different mass
- A balanced equation is needed to make a \_\_\_\_\_ comparison.



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- When solving these problems:
  - ALWAYS start with a balanced chemical equation
  - Determine molar masses needed
  - Determine mole ratio
  - Use a T chart, starting with given
- Ex. 4: Oxygen gas can be produced by decomposing potassium chlorate (potassium chloride is also produced). If 138.6 g of  $\text{KClO}_3$  is heated and decomposes completely, what mass of oxygen gas is produced?
  
- Ex. 5: A chemical reaction between diboron hexahydride and oxygen gas will produce Oxoborinic acid ( $\text{HBO}_2$ ) and water. A.) What mass of  $\text{O}_2$  will be needed to burn 36.1g of diboron hexahydride? B.) How many grams of water are produced from 19.2 g of  $\text{B}_2\text{H}_6$ ?

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## Limiting Reactants

- S'mores: A Non-Chemistry Example
  - What is the "formula" for making s'mores?
  - How many s'mores could I make if I had 8 gram crackers?
  - How many s'mores could I make if I had 8 marshmallows?
  - How many s'mores could I make if I had 8 chocolate squares?
  - If I have 8 gram crackers, 8 marshmallows, and 8 chocolate squares, how many s'mores could I make?
  - Which ingredient limits the amount of s'mores that can be made?
  - Which ingredients are excess (left over)? How much excess of those ingredients would you have?
- Limiting Reactant: is the reactant which limits how much the product is produced (also called limiting reagent).
  - The limiting reactant \_\_\_\_\_ and \_\_\_\_\_ is left over.
  - The Limiting Reactant \_\_\_\_\_ or \_\_\_\_\_ the reaction after it is entirely consumed.
- Excess Reactant: does not limit or stop a reaction from occurring (also called limiting reagent)
  - There will be an \_\_\_\_\_ or \_\_\_\_\_ of this reactant.
- Steps to determine the Limiting Reactant:
  - Step 1:
  - Step 2:
- Ex. 9: Aluminum reacts with chlorine to form aluminum chloride:  $2\text{Al} + 3\text{Cl}_2 \rightarrow 2\text{AlCl}_3$   
If you have 34.0 g of Al and 39.0 g of  $\text{Cl}_2$ , what is the limiting reactant? What is the excess reactant?

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- Ex. 10: When 3.22 moles of Al reacts with 4.96 moles of HBr, how many moles of H<sub>2</sub> are formed, considering the reaction below? What is the limiting reactant? What is the excess reactant?  
$$2 \text{ Al} + 6 \text{ HBr} \rightarrow 2 \text{ AlBr}_3 + 3 \text{ H}_2$$

- Ex. 11: Example 11: How many grams of aluminum sulfate are produced if 23.33 g Al reacts with 74.44 g CuSO<sub>4</sub>? What reactant limits the reaction? Which reactant will not be completely used up?  
$$\text{Al}_{(s)} + \text{CuSO}_4_{(aq)} \rightarrow \text{Al}_2(\text{SO}_4)_3_{(aq)} + \text{Cu}_{(s)}$$

### Percent Yield:

- Theoretical Yield:
- Actual Yield:
- Percent Yield:
- Ex. 12: What is the % yield of H<sub>2</sub>O if 138 g H<sub>2</sub>O is produced from 16 g H<sub>2</sub> and excess O<sub>2</sub>?
- Ex. 13: What is the % yield of NH<sub>3</sub> if 40.5 g NH<sub>3</sub> is produced from 20.0 mol H<sub>2</sub> and excess N<sub>2</sub>?

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- Ex. 14 Putting it all together: What is the % yield of H<sub>2</sub>O if 58 g H<sub>2</sub>O are produced by combining 60 g O<sub>2</sub> and 7.0 g H<sub>2</sub>? Hint: determine limiting reagent first
  
- Ex. 15: The electrolysis of water forms H<sub>2</sub> and O<sub>2</sub>. What is the % yield of O<sub>2</sub> if 12.3 g of O<sub>2</sub> is produced from the decomposition of 14.0 g H<sub>2</sub>O?
  
- Ex. 16: 107 g of oxygen is produced by heating 300 grams of potassium chlorate. Calculate % yield.  $2\text{KClO}_3 \rightarrow 2\text{KCl} + 3\text{O}_2$
  
- Example 17: What is the % yield of ferrous sulfide if 3.00 moles of Fe reacts with excess sulfur to produce 220 grams of ferrous sulfide?  $\text{Fe} + \text{S} \rightarrow \text{FeS}$