Name: _____ Date: _____ Period: _____

# S'mores Stoichiometry Lab

**Introduction:**
In this experiment, you will explore the principles of stoichiometry by building S'mores, the delicious, chocolate, marshmallow, and graham cracker treats.

**Definitions**: 'Stoichio' means element and 'metry' means the process of measuring. The mass and quantity relationships among reactants and products in a reaction are found using the process of stoichiometry.

**Purpose:**
To determine the limiting reactant in the synthesis of S'mores.

**Prelab Questions:**
1. What does a chemical equation tell us?
2. What do the coefficients in a balanced chemical equation represent?

**Materials:**

| | |
|---|---|
| Miniature Chocolate bars | Graham cracker Square |
| Marshmallows | Paper Towels |
| Bunsen Burner | Wooden skewers |

**Reference Data:**

| Substance | Symbol | Unit mass | Package Mass |
|---|---|---|---|
| Graham Cracker Squares | Gr | 8.50 g | 408 g |
| Marshmallow | Mm | 7.125 g | 285 g |
| Miniature Chocolate Bar | Ch | 12.00 g | 348 g |

** for the purposes of this lab the UNIT mass and MOLAR mass are the same thing

**Procedure:**
1. Perform a synthesis reaction (forming **one** s'more). For this lab, we will consider a s'more to consist of 2 graham cracker squares, 1 marshmallow and 1 miniature chocolate bar.
   a) Determine the formula for a s'more
   b) write the balanced chemical equation using the symbols above
   c) According to the balanced equation complete the following ratios:

| | | | | | |
|---|---|---|---|---|---|
| _____ | Gr = _____ | Mm | _____ | Gr = _____ | S'more |
| _____ | Ch = _____ | Mm | _____ | Mm = _____ | S'more |
| _____ | Ch = _____ | Gr | _____ | Ch = _____ | S'more |

2. Calculating the unit mass of the s'more.
   a) Calculate the mass on ONE s'more.
   b) Is there a relationship between the mass of a S'more and the masses of the reactants used to make it?
   c) If so, what is the relationship?
   d) What law have you studied in this course that might define this relationship?
3. Predicting the limiting reactant:
   a) Complete the data table below based on the materials provided for your group.

| Substance | Quantity received | # of S'mores it COULD make |
|---|---|---|
| Graham Cracker Squares | | |
| Marshmallow | | |
| Miniature Chocolate Bar | | |

   b) What will the limiting reactant be?
   c) How many of the other substances will remain
   d) What are the masses of each excess reactant that will remain once the reaction is complete?

4. Determining the limiting reactant experimentally:
    a) How many S'mores do you predict that you will be able to make using your reagents
    b) Test you hypothesis by performing the s'more synthesis reaction until one reactant is used up. Were you correct?
    c) Why or why not?
5. You may now consume your products while completing the post lab questions

Post Lab Questions:

1. S'more synthesis reaction
    a. If given 102 g of graham cracker squares, 85.5 g marshmallows, and 96 g chocolate, what is the limiting reactant in this S'more synthesis reaction? {HINT: convert grams into units}
    b. How many of each excess reactants will remain?
    c. What is the mass of each excess reactants will remaining?

2. Marshmallow madness
    a. Using the unit mass and package mass provided how many marshmallows are available in a whole package?
    b. Determine the units of graham crackers and chocolate segments are needed to consume an entire package of marshmallows.
    c. Using the unit masses determine the mass of graham crackers and chocolate segments needed.
    d. Using the package mass determine the number of packages of graham crackers and chocolate segments that you would need to consume an entire package of marshmallows.
    e. Show this as a single stoichiometric process on one line. Remember to cancel out all necessary units!

3. Graham Cracker Insanity
    a. Using the unit mass and package mass provided if you are given one box of graham crackers, what is the maximum number of S'mores that can be made?
    b. Determine the units of marshmallows and chocolate segments are needed to consume an entire package of marshmallows.
    c. Using the unit masses determine the mass of marshmallows and chocolate segments needed.
    d. How many bags of marshmallows and bags of miniature chocolate bars are needed to make this many S'mores?
    e. Show this as a single stoichiometric process on one line. Remember to cancel out all necessary units!

4. Simple Stoichiometry
    a. If we were to add a piece of solid Cu to an aqueous solution of silver nitrate, the Silver would be replaced in a single replacement reaction forming aqueous copper (II) nitrate and solid silver. How much silver is produced is 15.00 grams of Cu is added to the solution of excess silver nitrate?
        - Write and balance the chemical equation:
        - Convert grams Cu to moles Cu:
        - Convert moles of Cu to moles of Ag produced:
        - Convert moles Ag to grams of Ag produced:
        - If silver metal sells for $4.50/ounce [$4.50 = 1ounce and 1 gram = 0.0353 oz] , How much would the silver be worth?
        - Try writing this entire stoichiometric process on one line. Remember to cancel out all necessary units!

Teacher Notes:

**Primary Learning Outcome:**

Students will be able to identify and demonstrate the Law of Conservation of Matter.
Students will be able to write and balance a chemical equation for a synthesis reaction.
Students will be able to define and identify the limiting reactant of a reaction.
Students will be able to solve stoichiometry problems relating mass to moles and mass to mass.

**Assessed GPS:**

**SPS2. Students will explore the nature of matter, its classifications, and its system for naming types of matter.**

d. Demonstrate the Law of Conservation of Matter in a chemical reaction.
e. Apply the Law of Conservation of Matter by balancing the following types of chemical equations:
- Synthesis

**SC2. Students will relate how the Law of Conservation of Matter is used to determine chemical composition in compounds and chemical reactions.**

a. Identify and balance the following types of chemical equations: • Synthesis
d. Identify and solve different types of stoichiometry problems, specifically relating mass to moles and mass to mass.
e. Demonstrate the conceptual principle of limiting reactants.

**Duration:**

Preparation: 15 minutes
Pre-Lab: 10 minutes
Laboratory Assignment: 30 minutes
Post-Lab: 10 minutes
**Total Class Time: 50 minutes**

**Materials and Equipment:**

For Teacher Preparation:

1. Hershey's Chocolate bars
2. Marshmallows (large)
3. Graham crackers
4. Paper Plates
5. Bunsen Burner
6. Wooden skewers