



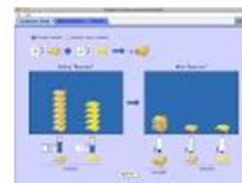
Name: \_\_\_\_\_ Pd: \_\_\_\_\_

## Basic Stoichiometry PhET Lab

*Let's make some sandwiches!*

### Introduction:

When we bake/cook something, we use a specific amount of each ingredient. Imagine if you made a batch of cookies and used way too many eggs, or not enough sugar. YUCK! In chemistry, reactions proceed with very specific recipes. The study of these recipes is *stoichiometry*. When the reactants are present in the correct amounts, the reaction will produce products. What happens if there are more or less of some of the reactants present?



**Reactants, Products and Leftovers**

**Vocabulary:** Before you begin, please define the following terms:

Limiting Reactant: \_\_\_\_\_

Excess Reactant: \_\_\_\_\_

Synthesis Reaction: \_\_\_\_\_

Combustion Reaction: \_\_\_\_\_

Mole Ratio: \_\_\_\_\_

Diatomic Molecule: \_\_\_\_\_

Mole: \_\_\_\_\_

Hydrocarbon: \_\_\_\_\_

**Procedure:** *PhET Simulations* → *Play with the Sims* → *Chemistry* → *Reactants, Products, and Leftovers* Run Now!

If a yellow bar drops down in your browser, click on it and select "Allow Blocked Content"

### Part 1: Making Sandwiches:

Sandwich Shop

- The Cheese Sandwich is a simulation of a two-reactant *synthesis* reaction. In this case, one reactant will be *limiting*, while the other will be in excess.
- Take some time and familiarize yourself with the simulation.



- Set the reaction to a simple mole ratio of 2:1:1
- Complete the table below while making tasty cheese sandwiches:

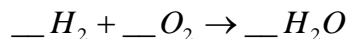
Bread Used	Cheese Used	Sandwiches Made	Excess Bread	Excess Cheese
5 slices	5 slices			
4 slices	3slices			
		2 sandwiches	1 slice	0 slices
6 slices		3 sandwiches		4 slices

**Real Reaction**

**Part 2: Real Chemical Reactions:**



5. Now let's work with real chemical reaction, one that creates a very entertaining BOOM!  
 6. What is the mole ratio for the reaction of hydrogen and oxygen to produce water?



7. Complete the table below while making water H<sub>2</sub>O from hydrogen H<sub>2</sub> and oxygen O<sub>2</sub>:

Hydrogen Molecules H <sub>2</sub>	Oxygen Molecules O <sub>2</sub>	Water Molecules H <sub>2</sub> O	Excess H <sub>2</sub>	Excess O <sub>2</sub>
4 molecules	4 molecules			
7 molecules	6 molecules			
		3 molecules	0 molecules	0 molecules
9 moles	8 moles			
		4 moles	1 moles	3 moles
3.5 moles	2.5 moles			
1.5 moles		1.5 moles	0 moles	0 moles

8. Notice that the labels changed from **molecules** to **moles**. This does not change the mole ratio, as a mole is simply a large number of molecules. How many molecules is a mole? \_\_\_\_\_



9. Now try producing **ammonia**, a very important chemical in industry and farming.

10. What is the mole ratio for the production of ammonia?  $\underline{\quad} N_2 + \underline{\quad} H_2 \rightarrow \underline{\quad} NH_3$

11. Complete the table below:

Moles N <sub>2</sub>	Moles H <sub>2</sub>	Moles NH <sub>3</sub>	Excess N <sub>2</sub>	Excess H <sub>2</sub>
3 moles	6 moles			
6 moles	4 moles			
		4 moles	2 moles	2 moles

12. Combustion of **hydrocarbons** like methane CH<sub>4</sub> produce two products, water and carbon dioxide CO<sub>2</sub>.

13. What is the mole ratio for the combustion of methane?  $\underline{\quad} CH_4 + \underline{\quad} O_2 \rightarrow \underline{\quad} CO_2 + \underline{\quad} H_2O$

14. Complete the table below:

mol CH <sub>4</sub>	mol O <sub>2</sub>	mol CO <sub>2</sub>	mol H <sub>2</sub> O	Excess mol CH <sub>4</sub>	Excess mol O <sub>2</sub>
4 mol	4 mol				
3 mol	6 mol				
		2 mol	4 mol	5 mol	1 mol
		3 mol		7 mol	1 mol

**Game!**

15. **The BEST PART:** Challenge other members of your lab group to the \_\_\_\_\_.

Your First Score: \_\_\_\_\_ |v| Your Best Score: \_\_\_\_\_ |v| Your Lab Group's Best Score: \_\_\_\_\_ |v|

*You may take this lab home to help you with the post-lab homework sheet, due next time.*

**Basic Stoichiometry Post-Lab Homework Exercises**

1. Load the "Reactants, Products, and Leftovers" simulation and work through each of the levels of the **Game!** At home, you can find the simulation by going to <http://phet.colorado.edu/> or googling "phet." You may have to download or update the version of *Java* on your computer.

Complete each exercise on your own. Remember to use proper units and labels.

2. For the reaction  $\_\_ N_2 + \_\_ O_2 \rightarrow \_\_ NO_2$  determine the correct lowest mole ratio.

3. For the reaction  $\_\_ SO_2 + \_\_ O_2 \rightarrow \_\_ SO_3$  determine the correct lowest mole ratio.

4. For the reaction  $P_4 + 6Cl_2 \rightarrow 4PCl_3$ , determine how many moles of chlorine  $Cl_2$  would be needed to react with 3 moles of phosphorus  $P_4$  to entirely use up all the phosphorus. 4) \_\_\_\_\_

5. If 5 moles of  $P_4$  reacted with 22 moles  $Cl_2$  according to the above reaction, determine:

a) How many moles  $PCl_3$  are produced a) \_\_\_\_\_

b) How many moles of  $P_4$  are left in excess after the reaction (if any) b) \_\_\_\_\_

c) How many moles of  $Cl_2$  are left in excess after the reaction (if any) c) \_\_\_\_\_

In reality, reactants don't have to react in perfect whole-numbers of moles. In a two-reactant synthesis reaction, usually one reactant gets entirely used up, even if that means using fractions of a mole of reactant. For instance, when solid, metallic aluminum  $Al$  and red, liquid bromine  $Br_2$  are brought together, they make a white solid according to the reaction  $2Al + 3Br_2 \rightarrow 2AlBr_3$ . If 5 moles of aluminum  $Al$  was reacted with 10 moles bromine  $Br_2$ , all five moles of aluminum would react, with 7.5 moles bromine. (2:3 mole ratio)

6. Now assume 3 moles  $Al$  and 4 moles  $Br_2$  react

a) Which chemical is the limiting reactant? a) \_\_\_\_\_

b) Which chemical must be the *excess reactant*? b) \_\_\_\_\_

c) How much (in moles)  $AlBr_3$  gets produced? c) \_\_\_\_\_

d) If all the limiting reactant gets used up, how much of the excess reactant is left? d) \_\_\_\_\_

7. What is the maximum amount (in moles) of  $NaCl$  that can be produced from 3.4 moles of  $Na$  and 4.5 moles of  $Cl_2$  according to the reaction  $\_\_ Na + \_\_ Cl_2 \rightarrow \_\_ NaCl$  (left for you to balance).

7) \_\_\_\_\_