



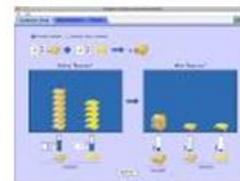
Name: _____ Pd: _____

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.



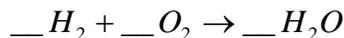
- Set the reaction to a simple mole ratio of 2:1:1
- Complete the table below while making tasty sandwiches:

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 H₂O from hydrogen H₂ and oxygen O₂:

Hydrogen Molecules H ₂	Oxygen Molecules O ₂	Water Molecules H ₂ O	Excess H ₂	Excess O ₂
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 ₂	Moles H ₂	Moles NH ₃	Excess N ₂	Excess H ₂
3 moles	6 moles			
6 moles	4 moles			
		4 moles	2 moles	2 moles

12. Combustion of **hydrocarbons** like methane CH₄ produce two products, water and carbon dioxide CO₂.

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 ₄	mol O ₂	mol CO ₂	mol H ₂ O	Excess mol CH ₄	Excess mol O ₂
4 mol	4 mol				
3 mol	6 mol				
		2 mol	4 mol	5 mol	1 mol
		3 mol		7 mol	1 mol

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

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) _____