M Witting, revised  Simulations at http://phet.colorado.edu/ Name:_____

Basic Stoichiometry PhET Lab

Let's make some sandviches!

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?

Vocabulary: Before you begin, please define the following:

Limiting Reactant: _____

Excess Reactant: _____

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 Sandviches: Sandwich Shop

1. 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.
2. Take some time and familiarize yourself with the simulation.
3. Set the reaction to a simple mole ratio of 2:1:1 
4. 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

Part 2: Real Chemical Reactions: Real Reaction

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?

$$\_\_H_2 + \_\_O_2 \rightarrow \_\_H_2O$$

7. Complete the table below while making water H_2O from hydrogen H_2 and oxygen O_2:

Hydrogen Molecules H_2	Oxygen Molecules O_2	Water Molecules H_2O	Excess H_2	Excess O_2
4 molecules	4 molecules			
7 molecules	6 molecules			
		4 molecules	0 molecules	0 molecules
9 moles	8 moles			
		4 moles	1 moles	0 moles
4.0 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? $\_\_N_2 + \_\_H_2 \rightarrow \_\_NH_3$
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	3 moles			
		4 moles	2 moles	0 moles
1.5 moles	4.0 moles			

12. Combustion of **hydrocarbons** like methane CH_4 produces two products, water and carbon dioxide CO_2.
13. What is the mole ratio for the combustion of methane? $\_\_CH_4 + \_\_O_2 \rightarrow \_\_CO_2 + \_\_H_2O$
14. Complete the table below: **WATCH FOR FRACTIONS**

mol CH_4	mol O_2	mol CO_2	mol H_2O	Excess mol CH_4	Excess mol O_2
4 mol	4 mol				
3 mol	6 mol				
		2 mol	4 mol		
		3 mol			

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

Your First Score:_____lvl__ Your Best Score:_____lvl__ Your Lab Group's Best Score:_____lvl__

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 (and determines how much product is made)**, 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 5.0 moles of aluminum Al was reacted with 10 moles bromine Br_2, all five moles of aluminum would react, with only 7.5 moles bromine. (2:3 mole ratio) This would produce only 5.0 moles of $AlBr_3$, leaving 2.5 moles of excess Br_2 behind.

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)_____

SHOW WORK HERE:

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

SHOW WORK HERE:

7. What is the maximum amount (in moles) of NaCl that can be produced from 4.5 moles of Na and 3.5 moles of Cl_2 according to the reaction $\_\_ Na + \_\_ Cl_2 \rightarrow \_\_ NaCl$ (left for you to balance).

SHOW WORK HERE:

7)_____