**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: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

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

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

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

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

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

**Procedure:** *PhET Simulations 🡪 Play with the Sims 🡪 Chemistry 🡪 Reactants, Products, and Leftovers*

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**Part 1: Making Sandviches:** 

1. The  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:** 

1. **![MC900434816[1]]()**Now let's work with real chemical reaction, one that creates a very entertaining BOOM!
2. What is the mole ratio for the reaction of hydrogen and oxygen to produce water?



1. Complete the table below while making water H2O from hydrogen H2 and oxygen O2:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Hydrogen Molecules H2 | Oxygen Molecules O2 | Water Molecules H2O | Excess H2 | Excess O2 |
| 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 |

1. ![MC900417464[1]]()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? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Now try producing **ammonia**, a very important chemical in industry and farming.
3. What is the mole ratio for the production of ammonia? 
4. Complete the table below:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Moles N2 | Moles H2 | Moles NH3 | Excess N2 | Excess H2 |
| 3 moles | 6 moles |  |  |  |
| 6 moles | 3 moles |  |  |  |
|  |  | 4 moles | 2 moles | 0 moles |
| 1.5 moles | 4.0 moles |  |  |  |

1. Combustion of **hydrocarbons** like methane CH4 produces two products, water and carbon dioxide CO2.
2. What is the mole ratio for the combustion of methane? 
3. Complete the table below: **WATCH FOR FRACTIONS**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| mol CH4 | mol O2 | mol CO2 | mol H2O | Excess mol CH4 | Excess mol O2 |
| 4 mol | 4 mol |  |  |  |  |
| 3 mol | 6 mol |  |  |  |  |
|  |  | 2 mol | 4 mol |  |  |
|  |  | 3 mol |  |  |  |

1. **The BEST PART**: Challenge other members of your lab group to the .

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 determine the correct lowest mole ratio.

3. For the reaction determine the correct lowest mole ratio.

4. For the reaction, determine how many moles of chlorine Cl2 would be needed to react with 3 moles of phosphorus P4 to entirely use up all the phosphorus. 4)\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

5. If 5 moles of P4 reacted with 22 moles Cl2 according to the above reaction, determine:

a) How many moles PCl3 are produced a)\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

b) How many moles of P4 are left in excess after the reaction (if any) b)\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

c) How many moles of Cl2 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 Br2 are brought together, they make a white solid according to the reaction . If 5.0 moles of aluminum Al was reacted with 10 moles bromine Br2, 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 AlBr3, leaving 2.5 moles of excess Br2 behind.

6. Now assume 3 moles Al and 4 moles Br2 react

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

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

c)How much (in moles) AlBr3 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 Cl2 according to the reaction (left for you to balance).

*SHOW WORK HERE:*

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