**Reactants, Products & Leftovers Experiment**

**This activity supports the following unit and course objectives:**

(CLO4) Demonstrate knowledge of basic laboratory skills and operations in the areas of safety, measurement, chemical and physical properties of matter, atomic and molecular structure, chemical reactions, reactivity, structure, periodicity, and bonding.

Reaction Stoichiometry (7.3)

* (7.3.1) Explain the concept of stoichiometry as it pertains to chemical reactions (CLO1)
* (7.3.2) Use balanced chemical equations to derive stoichiometric factors relating to amounts of reactants and products (CLO1)(CLO2)
* (7.3.3) Perform stoichiometric calculations involving mass, moles, and solution molarity (CLO2)

Reaction Yields (7.4)

* (7.4.1) Explain the concepts of theoretical yield and limiting reactants/reagents. (CLO1)
* (7.4.2) Derive the theoretical yield for a reaction under specified conditions. (CLO2)
* (7.4.3) Calculate the percent yield for a reaction. (CLO2)

**In addition to the unit and course objectives, this activity supports the following activity objectives:**

* Use concrete everyday experiences to describe the what a limiting reactant means in chemical reactions. (7.4.1)
* Identify the limiting reactant in a chemical reaction. (7.3.1) (7.4.1)
* Predict the products and leftovers after reaction, based on the quantities of reactants and ratios of molecules in the balanced chemical equation. (7.3.2) (7.3.3) (7.4.2) (7.4.3)
* Predict the initial amounts of reactants given the amount of products and leftovers using the concept of limiting reactant (7.3.2) (7.3.3) (7.4.2)(7.4.3)

**Directions:** Got to the [Reactants Simulator](http://phet.colorado.edu/sims/html/reactants-products-and-leftovers/latest/reactants-products-and-leftovers_en.html)

**On ‘sandwiches’ ‘ cheese’ sim:**

1. Start with 3 breads and 2 cheese. How many products are made? \_\_\_\_ What are the leftovers? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Add a slice of cheese. How many products are made? \_\_\_\_\_ What are the leftovers? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. Now have 8 breads and 3 cheese. How many products are made? \_\_\_\_\_ What are the leftovers? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. Now try 8 breads and 8 cheese. How many products are made? \_\_\_\_\_ What are the leftovers? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
5. With the 8 breads and 8 cheese – what did you run out of first? (this is your limiting reactant) \_\_\_\_\_\_\_\_\_\_\_\_\_
6. Now play with it and find out the max number of products which can be made without any leftovers. How many of each reactant were used? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
7. How many of the product was produced? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**On ‘sandwiches meat and cheese’ sim:**

1. Play with the sim and try to make only one sandwich with no leftovers. How many of each reactant were used? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Now max every reactant out. How many of each reactant is that? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. How many products can be made? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. How many of which leftovers are created? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
5. Which reactant was your limiting reagent? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
6. Now maximize the number of products without having any leftovers.
7. How many of each reactant are used? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
8. How many products were made? \_\_\_\_

**On ‘sandwiches custom’ sim:**

1. Set it on a triple decker meat and cheese sandwich at the top. How many of each reactant will you need to make one triple decker meat and cheese sandwich? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Now max out how many products can be made without leftovers.
3. How many of each reactant did you use? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. How many products did you produce? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
5. Now max out all of the reactants.
6. How many products were produced? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
7. How many of each leftover were there? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
8. What is the limiting reactant in the triple decker sandwich? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Using the ‘molecules – make water’ sim**

1. Make a single water molecule. How many of each reactant were used? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. What is the mole ratio (how many of each reactant and product are there)? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. Now write it as a chemical reaction: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. Max out how many water molecules that can be made without leftovers/excess.
5. How many of each reactant were used? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
6. How many products were produced? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
7. What is the mol ratio (how many of each reactant and product are there)? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
8. Now express it as a chemical equation: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
9. Now max out every reactant.
10. How many products were made? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
11. How many and what were the leftovers/excess? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
12. What is the limiting reactant? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Using the ‘molecules – make ammonia’ sim**

1. Make a single ammonia molecule.
2. How many of each reactant were used? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. What is the mol ratio? \_\_\_\_\_\_\_\_\_\_\_\_\_
4. Write it as a chemical equation: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
5. Play with it until you find the max amount of ammonia that can be produced without any leftovers.
6. How many of each reactant are used? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
7. How many ammonia molecules are produced? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
8. Write it as a chemical equation: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
9. Now max all of the reactants.
10. How many ammonia molecules are produced? \_\_\_\_\_\_\_\_\_\_\_\_\_\_
11. How many of each leftover are there? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
12. What is the limiting reactant in this reaction? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Using the ‘molecules – combust methane’ sim**

1. Produce a single carbon dioxide molecule without any leftovers.
2. How many of each reactant are used? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. How many of each product are produced? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. What is the mol ratio: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
5. Write the reactant in a chemical equation form: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
6. Now max all of the reactants out.
7. How many of each product are formed? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
8. How many of what leftover are there? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
9. Now maximize the number of products produced without leftovers.
10. How many of each reactant are consumed? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
11. How many of each product are produced? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
12. What is the mol ratio? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
13. Now write it as a chemical equation: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
14. What is the limiting reagent in this reaction? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
15. How do you know? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Now use the ‘Reactants, Products & Leftovers – Game’**

When you have scored an 8 or better on level 1 \_\_\_\_\_\_ You’re up to a ‘C’ for this assignment.

When you have scored an 8 or better on level 2 \_\_\_\_\_\_ You’re now up to a ‘B’ for this assignment.

When you have scored an 8 or better on level 3 \_\_\_\_\_\_\_\_You’re now up to an ‘A’ for this assignment