Introduction to Limiting and Excess Reactants

Name:_______________________________

General Chemistry

Date:____________________Hour_______

Introduction

In this activity you will learn about limiting and excess reactants in a chemical system.

Model 1 - S'mores Lab

Procedure

1. Safely make a s'more by using two graham crackers halves, one toasted marshmallow (you must wear goggles when using the Bunsen burner), and a ¼ of a chocolate bar.
2. Enjoy your s'more and answer the questions below.

Questions

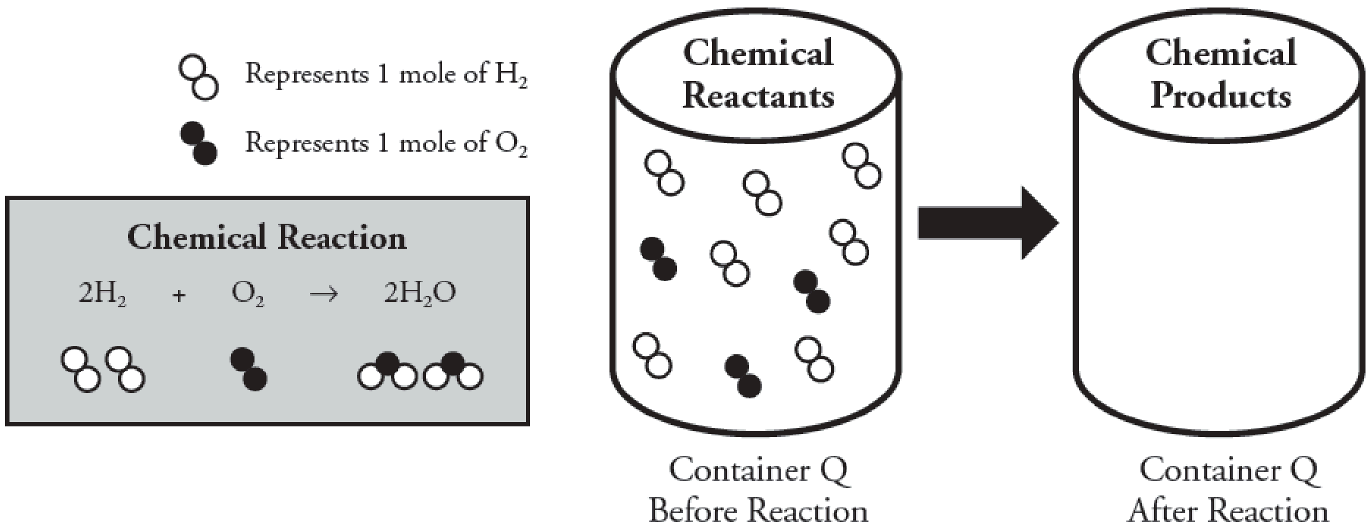
1) If the three ingredients above are required to make a traditional s'more, could you make a s'more without a chocolate bar? Explain.

2) If you need two graham cracker halves, one marshmallow and a ¼ of a chocolate bar to properly make a s'more, how many complete s'mores could you make with 15 whole graham crackers, 9 marshmallows and 8 whole chocolate bars? What is/are the limiting reactant(s) in this reaction? What is/are the excess reactant(s) and much is left over?

3) How many complete s'mores could you make with 10 whole graham crackers, 14 marshmallows and 6 whole chocolate bars? What is/are the limiting reactant(s) in this reaction? What is/are the excess reactant(s) and much is left over?

4) How many complete s'mores could you make with 20 whole graham crackers, 20 marshmallows and 9 whole chocolate bars? What is/are the limiting reactant(s) in this reaction? What is/are the excess reactant(s) and much is left over?

Model 2 – The Production of H_2O



5) Refer to the chemical reaction in **Model 2**. *HINT: Looking back at your answers from* ***Model 1*** *may help you answer the questions below.*

   a) How many moles of water molecules are produced if one mole of oxygen molecules completely reacts? How do you know?

   b) How many moles of hydrogen molecules are needed to react with one mole of oxygen molecules? How do you know?

6) Complete container Q in **Model 2** above by <u>**drawing**</u> the maximum moles of water molecules that can be produced from the given reactants. Then, draw any remaining, or excess, moles of reactant in Container Q.

   a) Which reactant (oxygen or hydrogen) limited the production of water in Container Q? In other words, which reactant was used up first? This is considered the **limiting reactant**.

   b) Which reactant (oxygen or hydrogen) was present in excess and remained after the production of water was complete? How many moles of molecules was left over? This is considered the **excess reactant**.

Read This!
In **Model 2** we used the particle drawings to match up the hydrogen and oxygen molecules that will react to form water. From this, we determined the maximum amount of water molecules that could be produced based on the **limiting reactant**. Anything left over was considered to be an **excess reactant**.

Up to this point, we have always had 1 reactant that was used to completion -- this is the **limiting reactant**! What if we don't know which reactant will be used to completion? Can we still determine the limiting reactant? Yes, we can! We have to calculate what is *actually* used in the reaction. We will practice this idea using BCA tables.

Summarize the **Read This!** section in 1-2 sentences:

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Model 3 - BCA Tables

Container Q contains 7 moles of H_2 and 3 moles of O_2 molecules and we need to complete the BCA table. You'll notice the BCA table needed to be completed twice...there's a reason for that. Read through the step-by-step tutorial below the BCA tables.

$$2\ H_2 + O_2 \rightarrow 2\ H_2O$$

Container Q
Assume H_2 reacts to completion

	H_2	O_2	H_2O
B	7 mol	3 mol	0 mol
C	***-7 mol***	***-3.5mol***	
A	***0 mol***	***Not enough!***	

Container Q
Assume O_2 reacts to completion

	H_2	O_2	H_2O
B	7 mol	3 mol	0 mol
C	***-6 mol***	***-3 mol***	***+6 mol***
A	***1 mol***	***0 mol***	***6 mol***

- Assume that 7 moles of H_2 react to completion.
- If there are 7 mol of H_2 present, how much O_2 will *actually* react?

$$\left(\frac{7\ mol\ H2}{1}\right)\left(\frac{1\ mol\ O2}{2\ mol\ H2}\right) = 3.5\ mol\ of\ O_2$$

- Wait! We need 3.5 mol of O_2 to completely react with H_2! We only have 3 mol of O_2…So, we don't have enough O_2! This means that oxygen is the **limiting reactant**.
- We have to fill the table using O_2, instead….

- Assume that 3 moles of O_2 react to completion.
- If there are 3 mol of O_2 present, how much H_2 will *actually* react?

$$\left(\frac{3\ mol\ O2}{1}\right)\left(\frac{2\ mol\ H2}{1\ mol\ O2}\right) = 6\ mol\ of\ H_2$$

- We need 6 mol of H_2 for this reaction, and we are starting with 7 mol…we have enough! How much H_2O can we make?

$$\left(\frac{3\ mol\ O2}{1}\right)\left(\frac{2\ mol\ H2O}{1\ mol\ O2}\right) = 6\ mol\ of\ H_2O$$

- Complete the BCA table by filling in the "A" (after) row. If O_2 is the **limiting reactant**, then H_2 is the **excess reactant** and we will have 1 mol of H_2 remaining.

  7 mol H_2 **<u>B</u>**efore - 6 mol H_2 used = 1 mol H_2 **<u>A</u>**fter

- The maximum amount of H_2O we can make is 6 mol.

7) How do you determine which substance is the limiting reactant? Create a flow chart or a list of steps.

Now You Try!

Refer to **Model 3** to help you complete the BCA tables for containers *R-T*. Containers *R-T* contain various amounts of moles of hydrogen and oxygen molecules. Use the balanced chemical equation and dimensional analysis to complete the BCA table for each of the containers to show how many moles of water molecules can be produced.

$$2\ H_2 + O_2 \rightarrow 2\ H_2O$$

8)

Container R			
	H_2	O_2	H_2O
B	8 mol	3 mol	
C			
A			

What is the maximum amount of moles of water molecules that can be made in container *R*? ___________

What is the limiting reactant in *R*? _____________ How much excess reactant remains in *R*? ___________

9)

Container S			
	H_2	O_2	H_2O
B	10 mol	3 mol	
C			
A			

What is the maximum amount of moles of water molecules that can be made in container *S*? ____________

What is the limiting reactant in *S*? _____________ How much excess reactant remains in *S*? ____________

10)

Container T			
	H_2	O_2	H_2O
B	5 mol	3 mol	
C			
A			

What is the maximum amount of moles of water molecules that can be made in container *T*? ____________

What is the limiting reactant in *T*? _____________ How much excess reactant remains in *T*? ___________

More Practice!

Containers A-D contain various amounts of moles of solid aluminum and oxygen molecules. Use the balanced chemical equation to complete the BCA table for each container.

$$4\ Al_{(s)} + 3\ O_{2\ (g)} \rightarrow 2\ Al_2O_{3\ (s)}$$

11)	Container A		
	Al	O_2	Al_2O_3
B	9 mol	7 mol	
C			
A			

What is the maximum amount of moles of water molecules that can be made in container *A*?

What is the limiting reactant in *A*?

How much excess reactant remains in *A*?

12)	Container B		
	Al	O_2	Al_2O_3
B	8 mol	7 mol	
C			
A			

What is the maximum amount of moles of water molecules that can be made in container *B*?

What is the limiting reactant in *B*?

How much excess reactant remains in *B*?

13)	Container C		
	Al	O_2	Al_2O_3
B	5 mol	2 mol	
C			
A			

What is the maximum amount of moles of water molecules that can be made in container *C*?

What is the limiting reactant in *C*?

How much excess reactant remains in *C*?

14)	Container D		
	Al	O_2	Al_2O_3
B	17 mol	11 mol	
C			
A			

What is the maximum amount of moles of water molecules that can be made in container *D*?

What is the limiting reactant in *D*?

How much excess reactant remains in *D*?