This is BCE#9.

I recommend you print out this page and bring it to class. Click here to show a set of five BCE9 student responses randomly selected from all of the student responses thus far in a new window.

john , here are your responses to the BCE and the Expert's response.

In this BCE we will investigate a chemical reaction as viewed at the particulate level. In Table I below are three experiments that you are to perform using a simulation of a chemical reaction. Click on the link for Exp #1. When the simulation appears in a new window, resize the window to allow you to see the simulation and this BCE window. After resizing the window note the number and kind of reacting particles, then click on the Enable Reaction button and then the Resume button; (Note you may want to reduce the volume of the container if the reaction is too slow.) If your browser is not accessorized to run Java you can get a free Java download (after you install Java follow these instructions) or you can watch this QuickTime movie of Exp#1, #2 and #3. You might consider pausing the video between each experiment to answer the appropriate questions in the BCE. Watch the particles carefully so you observe exactly what is happening. Complete the tables following exp. #2 and Exp. #3. The table for Exp. #1 is completed for you but be sure you agree with each entry in the table. You are also welcome to use a computer in PS102.

Table I.

Experiment	Reactant1 (R)	Reactant2 (GB)
Exp #1	4	4

Briefly describe what you observed happening in the reaction container Before and then After clicking on the Enable Reaction button. (NOTE: Use words like molecules atoms, collision, velocity, reaction, reactants and products.)

BG molecules collide with R atom to produce RG molecule and a B atom

Before clicking on the Enable Reaction button there are four GB molecules and four R atoms moving around in the container colliding with each other and the walls of the container. The particles appear to have different velocities that change when colliding with another particle. When the Enable Reaction button is clicked a reaction occurs between the GB molecule and the R atom when the R atom collides

with the GB molecule at the G side of the molecule. The products formed are an RG molecule and a B atom. The reaction continues until all four GB molecules and R atom collide correctly to form four RG molecules and four B atoms.

Table II for Experiment #1 has been completed with all the information. It is important to note that the row labeled 'Initial Amount' is completed before the Enable Reaction button is clicked, that the row labeled 'Final Amount' is completed after the reaction has gone to completion, and finally the row labeled 'Change Amount' can be completed last. It is essential to note that the it is only the 'Change Amount' row that adheres to the stoichiometry indicated by the coefficients in the balanced chemical equation. That neither the 'Initial Amount' row or the 'Final Amount' row adhere to the stoichiometry indicated by the coefficients in the balanced chemical equation.

To summarize what happens in the simulation for Exp #1 look at Table II. which has been completed as an example.

Table II: Experiment #1.

	REACTANTS	REACTANTS		PRODUCTS	PRODUCTS
Exp. #1	Reactant(1)	Reactant(2)		Product(1)	Product(2)
Formula	R	BG	--->	RG	B
Initial Amount	4	4		0	0
Change Amount	-4	-4		+4	+4
Final Amount	0	0		4	4

How many Red atoms were present initially?

There are four Red atoms initially in the container.

How many Red atoms reacted?

All four Red atoms react. Enough time must be allowed for the reaction to go to completion.

How many RG molecules were formed?

Four RG molecules are produced.

Now perform Experiment #2 - #3: To access each experiment click the mouse on the Exp # link below. This will open a new window containing a reaction container. Complete Table II for Exp#2 and #3 in the same way as Table II for Exp #1 above.

Experiment	Reactant1 (R)	Reactant2 (GB)
Exp #2	4	2
Exp #3	2	4

Reminder Instructions: **Enter the formula for each reactant (recommend using the capitalized first letter for the color(s) of the particle as it formula, for example R and BG) and the initial amount of each reactant in Table II: Experiment #2 or #3. After recording this information for the particular experiment (#2 or #3) in the appropriate table, click on the Resume Button and then click on the Enable Reaction button and then observe what takes place in the reaction container. After the reaction is 'complete' enter the formula(s) of the product(s) of the reaction in the table. Also enter the final amounts of the reactants and the product(s) in the table.**

Table II: Experiment #2

	REACTANTS	REACTANTS		PRODUCTS	PRODUCTS
Exp. #2	Reactant(1)	Reactant(2)		Product(1)	Product(2)
Formula	R R	BG GB	--->	RG RG	RG B
Initial Amount	4 4	2 2		0 0	0 0

Change Amount	-2 -2	-2 -2		+2 +2	+2 +2
Final Amount	2 2	0 0		2 2	2 2

Table II: Experiment #3.

	REACTANTS	REACTANTS		PRODUCTS	PRODUCTS
Exp. #3	Reactant(1)	Reactant(2)		Product(1)	Product(2)
Formula	R R	BG GB	--->	RG RG	B B
Initial Amount	2 2	4 4		0 0	0 0
Change Amount	-2 -2	-2 -2		+2	+2
Final Amount	0	2		2	2

Write a balanced chemical equation describing the reaction you observed in each experiment. (Use a format similar to R1 + R2 --> P1 + P2 when writing the equation for the reactions observed. Use a single space to separate reactants, products, plus sign and the reaction arrow.)

Exp. #1: $4R + 4GB \rightarrow 4RG + 4B$ 31%
$R4 + GB4 \rightarrow RG4 + B4$ 7%

The equation for the reaction is R + GB ---> RG + B 40%

Exp. #2:

The equation for the reaction is R + GB ---> RG + B

Exp. #3:

The equation for the reaction is R + GB ---> RG + B

It is important to note that the chemical equation that describes the reaction that occurs is the same each time. A balanced equation never depends on the amounts of the reactants or products. A balanced chemical equation only tells us the ratio which reactants combine and form products.

A reagent in excess is a reactant that is not completely used up in a chemical reaction, a limiting reagent is a reactant that limits the amount of product formed in a chemical reaction. Look back at Table II Exp#1, #2 and #3 and select one of the radioboxes below that best fits the assignment of the excess reagent and the limiting reagent.

In Exp #1: (do as a group radiobutton)

- ☐ **R is the excess reagent and GB is the limiting reagent:** 13%
- ☐ **GB is the excess reagent and R is the limiting reagent:** 14%
- ☐ **both R and GB are excess reagents:** 15%
- ☐ **both R and GB are limiting reagents** 68%

In Experiment #1 since both reactants completely reacted and there are no particles of either reactant remaining after the reaction is complete, there cannot be an excess reagent. So both reactants are limiting. This will happen anytime there is a stoichiometrically related amount of both reactants.

In Exp #2:

- ☐ **R is the excess reagent and GB is the limiting reagent:** 79%
- ☐ **GB is the excess reagent and R is the limiting reagent:** 20%
- ☐ **both R and GB are excess reagents:** 8%
- ☐ **both R and GB are limiting reagents**

In Experiment #2 since R and BG react in one to one ratio, and there is more R initially than GB, R is in excess and GB is the limiting reagent. Note it is important to remember that it is a combination of the coefficients associated with each

reactant and the initial amount that must be used to determine the reactant that is excess and the limiting reactant.

In Exp #3:

- ☐ **R is the excess reagent and GB is the limiting reagent:**
- ☐ **GB is the excss reagent and R is the limiting reagent:**
- ☐ **both R and GB are excess reagents:**
- ☐ **both R and GB are limiting reagents**

In Experiment #3 since R and BG react in a one to one ratio, and there is more GB initially than R, GB is in excess and R is the limiting reagent. Note it is important to remember that it is a combination of the coefficients associated with each reactant and the initial amount that must be used to determine the reactant that is excess and the limiting reactant.

Is there anything about the questions that you feel you do not understand? List your concerns/questions.

If there is one question you would like to have answered in lecture, what would that question be?