Shifting Reactions B

Name______________________________Lab Section___________________________

Log on to the Internet. Type the following address into the location-input line of your browser:

http://introchem.chem.okstate.edu/DCICLA/ERGBN.htm

This will load a Graphics Simulation. Once you have the simulation running your screen will look like what is shown in Figure 1 below. If you haven't already done so, read the Graphics Simulation section of the Introduction to MoLEs Activities to learn how to use the simulation.

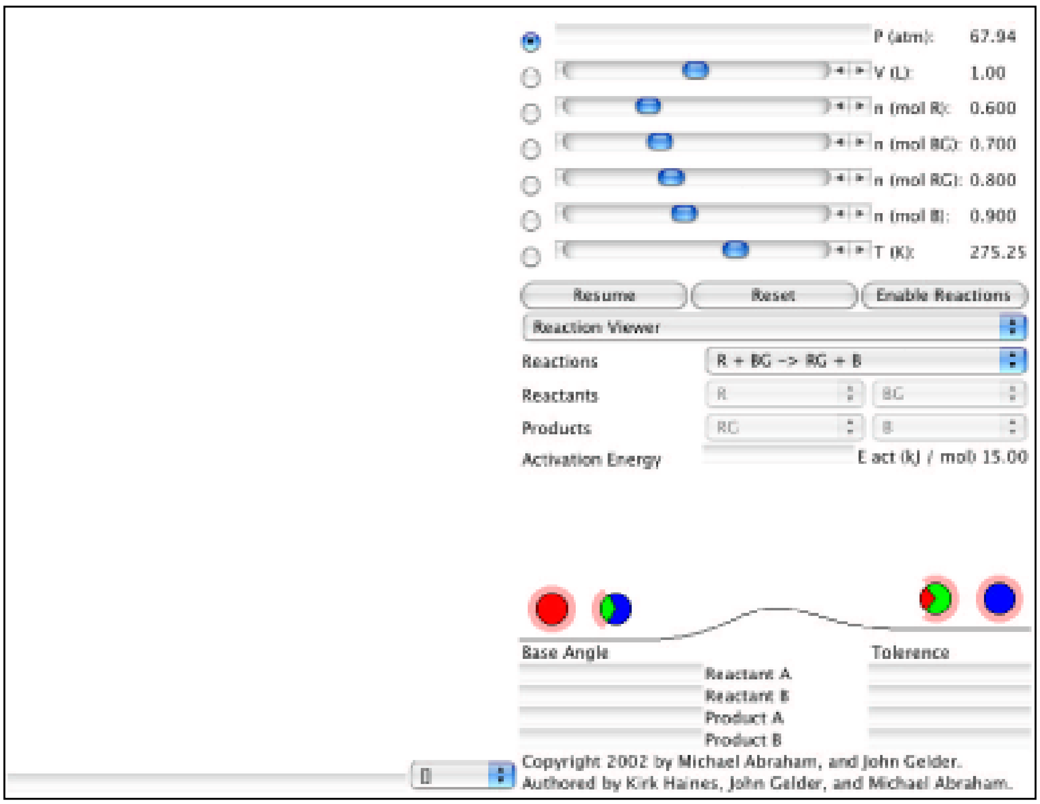


Figure 1.

Name________________________________ Lab Section______________________

Problem Statement: How can concentration changes affect a chemical reaction?

I. Data Collection:

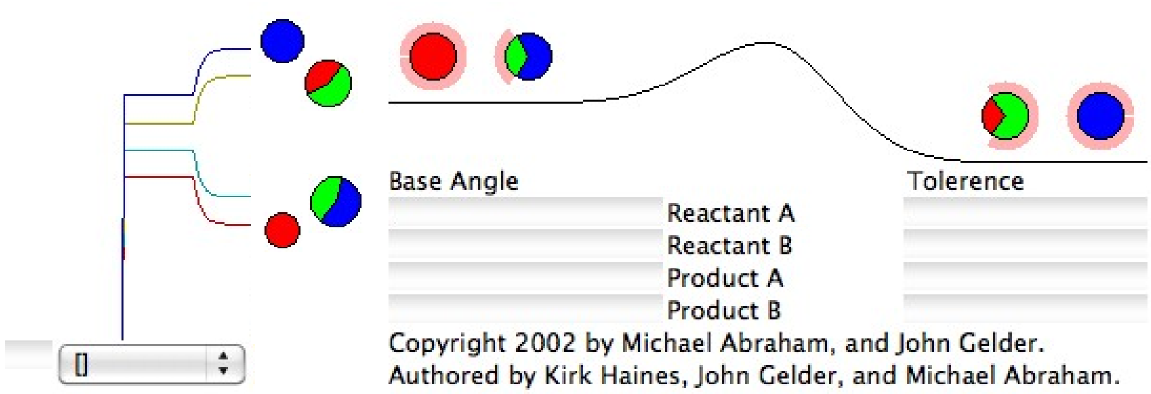
A. Open the Graphics Simulation program. Using the data from the Control Bar Region, enter the initial concentration of each substance in the equation, along with the initial pressure, volume and temperature into the table below.

EXPERIMENT #1:

	R	+ BG	→ RG	+ B	
Initial Concentration – I	**0.60**	**0.70**	**0.80**	**0.90**	
Concentration Change – C	**-0.17**	**-0.17**	**+0.17**	**+0.17**	
Ending Concentration – E	**0.43**	**0.53**	**0.97**	**1.07**	**(after enabling Reactions)**

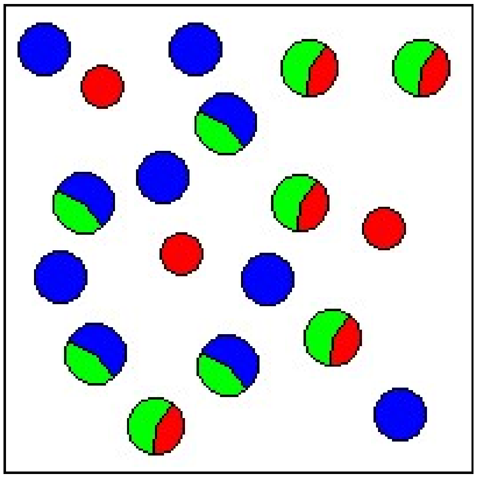
Pressure	**67.94 atm**
Volume	**1.00 L**
Temperature	**275.25 K**

B. Click on the Resume and then the Enable Reactions button to begin the reaction. When the reaction appears to be complete, click Pause to stop the action. Record the values of the ending concentrations in the table in Section 1A. Calculate the change in concentration of each of the substances in the reaction. In the space below, draw the appearance of the strip chart and label the axes. If necessary, use the scrollbar located under the strip chart to move the chart back to the beginning of the reaction. Identify the chemical substance that corresponds to each of the colored lines.

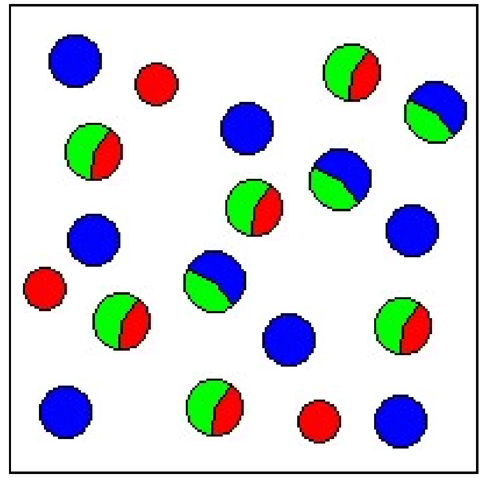


II. Data Analysis and Interpretation:

A. Mental Modeling: In the following boxes, draw pictures at the level of atoms and molecules that represents the initial and ending states of the reaction?



Initial



Ending

The important difference between the initial and the ending states should be;

1) **The amounts of R, BG, RG and B should be in the order atoms of R < molecules of BG < molecules of RG < atoms of B;**
2) **there is a change in the number of reactants and products going from the initial to the final state and the change should reflect the stoichiometry of the reaction 1 R reacts with 1 BG to form 1 RG and 1 B. SO check that the change from initial to final reflects that reactivity.**

B. Explain what is happening to each of the reactant and product substances over time. How does the strip chart illustrate the changes you observe?

Once the reaction begins it proceeds from left to right, so in the chart recording we see the concentration of R and BG decreasing and the concentration of RG and B increasing.

B. How can you tell when the reaction is complete? What substances are present when the reaction appears to be complete?

All substances are present in this system when the reaction reaches completion. When the concentration of all species remains constant we know the reaction is complete. To tell when there is no further change in the concentration we look for a flat horizontal line in the chart recording.

C. Considering the substances that are present when the reaction appears to be complete, why do the concentrations of the substances cease to change?

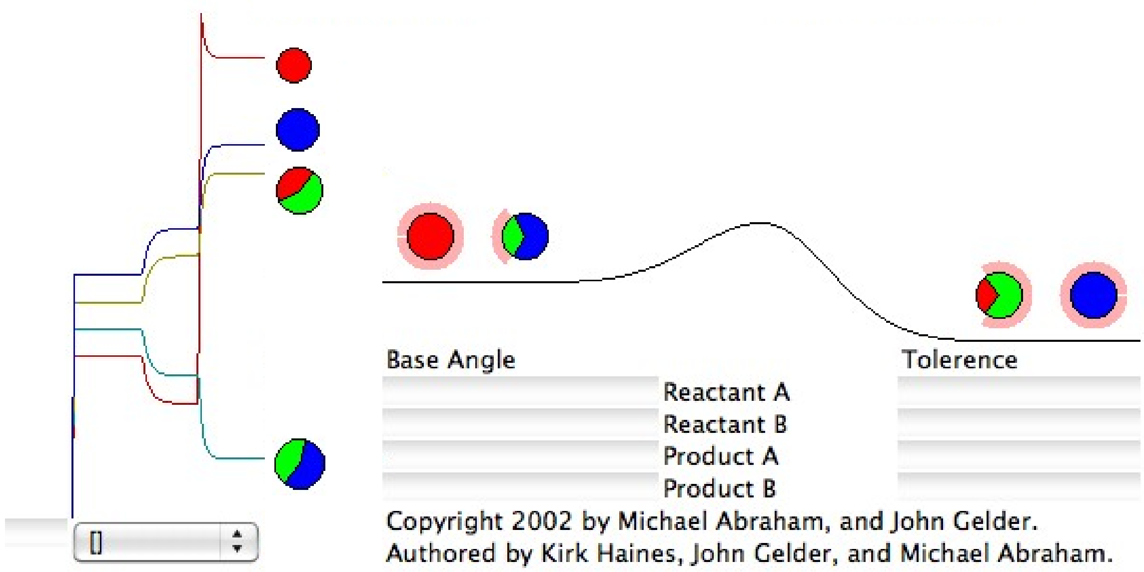
The concentrations cease to change because when the forward reaction occurs in one part of the system, the reverse reaction occurs in a different part of the system. So there is no net change. Initially when the reaction begins only the forward reaction occurs, but as more and more product is formed the reverse reaction begins. When the concentrations cease to change any forward reaction that occurs is balanced by a reverse reaction occurring at the same time.

III. Data Collection:

A. If necessary click Pause to stop the action. If you moved the strip chart scrollbar in the previous section, shift it back to as far to the right as it will go. Use the ending concentrations of BG, RG and B from Experiment #1 (Section 1A.) as the initial concentrations in this experiment. Enter those values in the table below. In the Control Bar Region add R until its concentration is 2.0 M. Record this initial concentration of R in the table below. Click the Resume button. Observe how the concentrations of the substances change over time. When the reaction appears to be complete click the Pause button. Record the values of the ending concentrations in this table and calculate the change in concentration of each of the substances in the reaction. Draw and label the appearance of the portion of the strip chart for this reaction. (NOTE: If necessary drag the Strip Chart scrollbar to the left.)

EXPERIMENT #2: Increase reactant R to 2.0 M

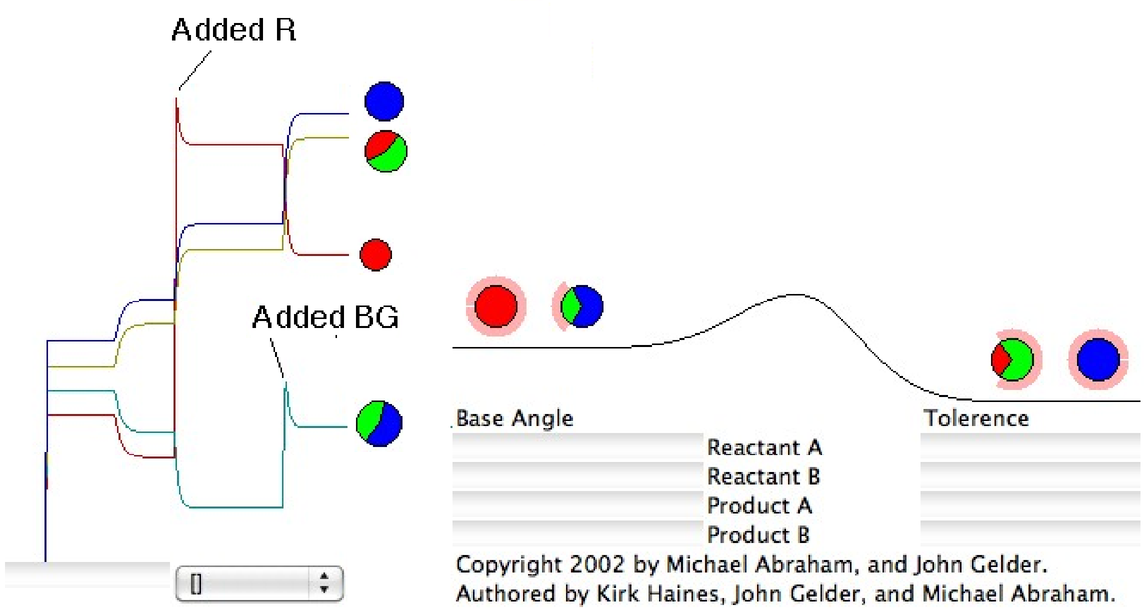
	R	+ BG	→ RG	+ B
Initial Concentration – I	**2.0**	**0.53**	**0.97**	**1.07**
Concentration Change – C	**-.304**	**-.304**	**+.304**	**+.304**
Ending Concentration – E	**1.696**	**.226**	**1.274**	**1.374**



If you moved the strip chart scrollbar in the previous section, shift it back to as far to the right as it will go. Use the ending concentrations of R, RG and B from Experiment #2 as the initial concentrations in this experiment. Enter those values in the table below. In the Control Bar Region add BG until its concentration is 1.0 M. Record this initial concentration of BG in the table below. Click the Resume button. Observe how the concentrations of the substances change over time. When the reaction is appears to be complete click the Pause button. Record the values of the ending concentrations in this table and calculate the change in concentration of each of the substances in the reaction. Draw and label the appearance of the portion of the strip chart for this reaction. (NOTE: If necessary drag the Strip Chart scrollbar to the left.)

EXPERIMENT #3: Increase reactant BG to 1.0 M

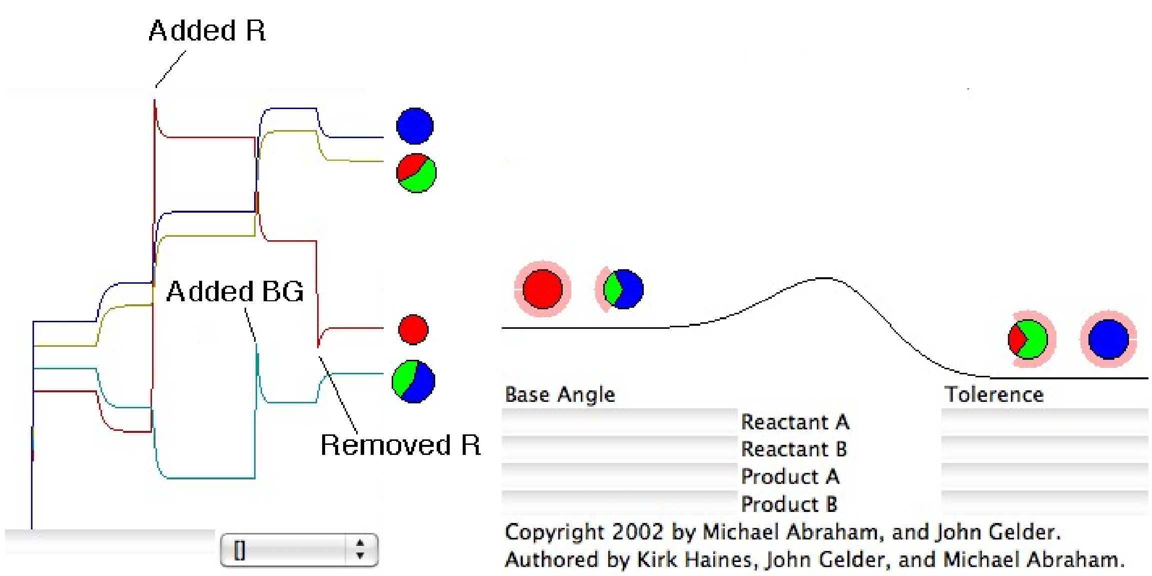
	R	BG	RG	B
	R +	BG →	RG +	B
Initial Concentration – I	**1.696**	**1.00**	**1.274**	**1.374**
Concentration Change – C	**-.448**	**-.448**	**+.448**	**+.448**
Ending Concentration – E	**1.248**	**0.552**	**1.722**	**1.822**



B. In a manner similar to the previous experiments remove R until its concentration equal 0.75 M. Record the new initial conditions of all substances in the table below. Click the Resume button. Observe how the concentrations of the particles in the sample change over time. When the reaction is appears to be complete click the Pause button. Record the values of the ending concentrations in the table and calculate the change in concentration of each of the substances in the reaction. Draw and label the appearance of the portion of the strip chart for this reaction.

EXPERIMENT #4: Decrease reactant R to 0.75 M

	R	+ BG	→ RG	+ B
Initial Concentration – I	**0.750**	**0.552**	**1.722**	**1.822**
Concentration Change – C	**+.126**	**+.126**	**-.126**	**-.126**
Ending Concentration – E	**0.876**	**0.678**	**1.596**	**1.696**



In a manner similar to the previous experiments add RG until its concentration is 2.0 M. Record the new initial conditions of all substances in the table below.

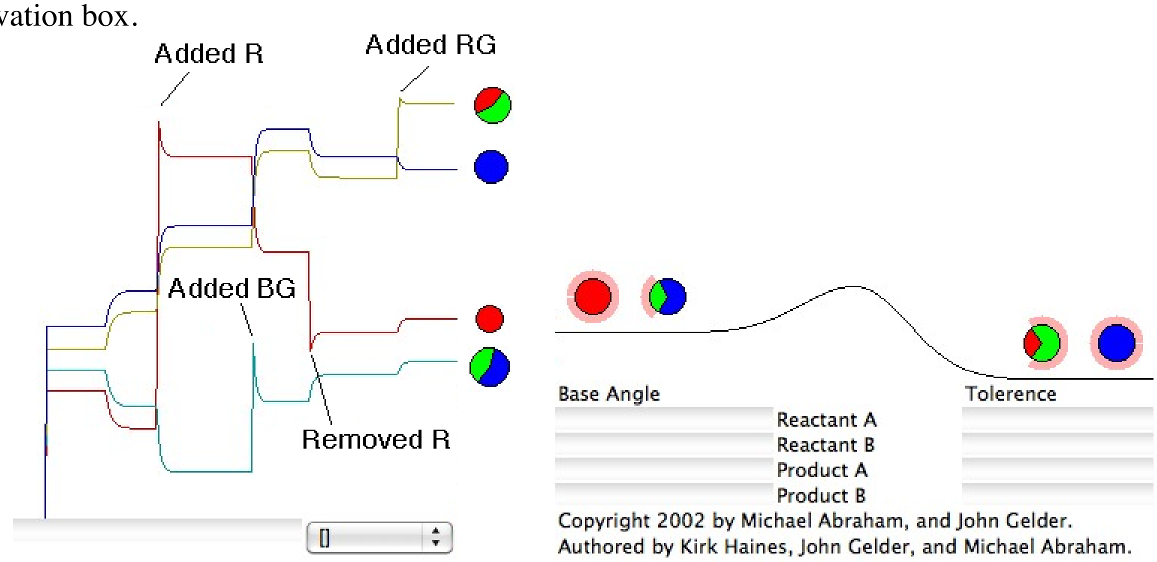
EXPERIMENT #5: Increase product RG to 2.0 M

	R	BG		RG	B
	R +	BG	→	RG +	B
Initial Concentration – I	**0.876**	**0.678**		**2.00**	**1.696**
Concentration Change – C	**+.062**	**+.062**		**-.062**	**-.062**
Ending Concentration – E	**0.938**	**0.740**		**1.938**	**1.633**

Before initiating the reaction draw what you think the Strip Chart Region will look like during this reaction in the box labeled Your Prediction.

Your Prediction:	Observation:
In this space the student draws their prediction of what the chart recorder will look like.	**See below for the observation.**

Click the Resume button. Observe how the concentrations of the particles in the sample change over time. When the reaction is appears to be complete click the Pause button. Record the values of the ending concentrations in the ICE table (above) and calculate the change in concentration of each of the substances in the reaction. Draw and label the appearance of the portion of the strip chart for this reaction in the Your Observation box.



In a manner similar to the previous experiments remove RG until its concentration is 1.0 M. Record the new initial conditions of all substances in the table below.

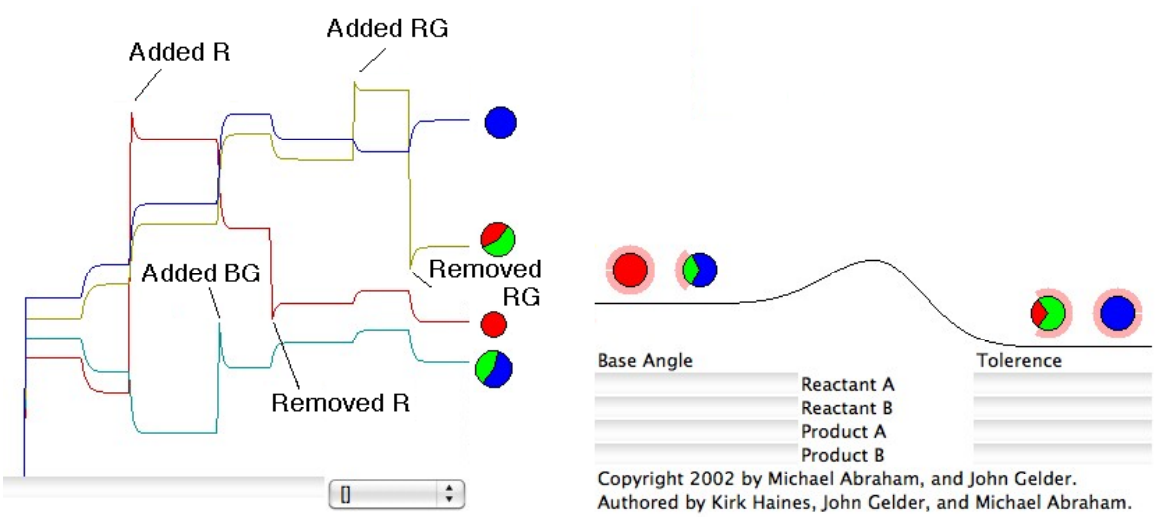
EXPERIMENT #6: Decrease product RG to 1.0 M

	R	+ BG	→ RG	+ B
Initial Concentration – I	**0.938**	**0.740**	**1.00**	**1.633**
Concentration Change – C	**-.158**	**-.158**	**+.158**	**+.158**
Ending Concentration – E	**0.781**	**0.583**	**1.158**	**1.791**

Before initiating the reaction draw what you think the Strip Chart Region will look like during this reaction in the box labeled Your Prediction.

Your Prediction:	Observation:
In this space the student draws their prediction of what the chart recorder will look like.	**See below for the observation.**

Click the Resume button. Observe how the concentrations of the particles in the sample change over time. When the reaction is appears to be complete click the Pause button. Record the values of the ending concentrations in the ICE table (above) and calculate the change in concentration of each of the substances in the reaction. Draw and label the appearance of the portion of the strip chart for this reaction in the Your Observation box.



IV. Data Analysis and Interpretation:

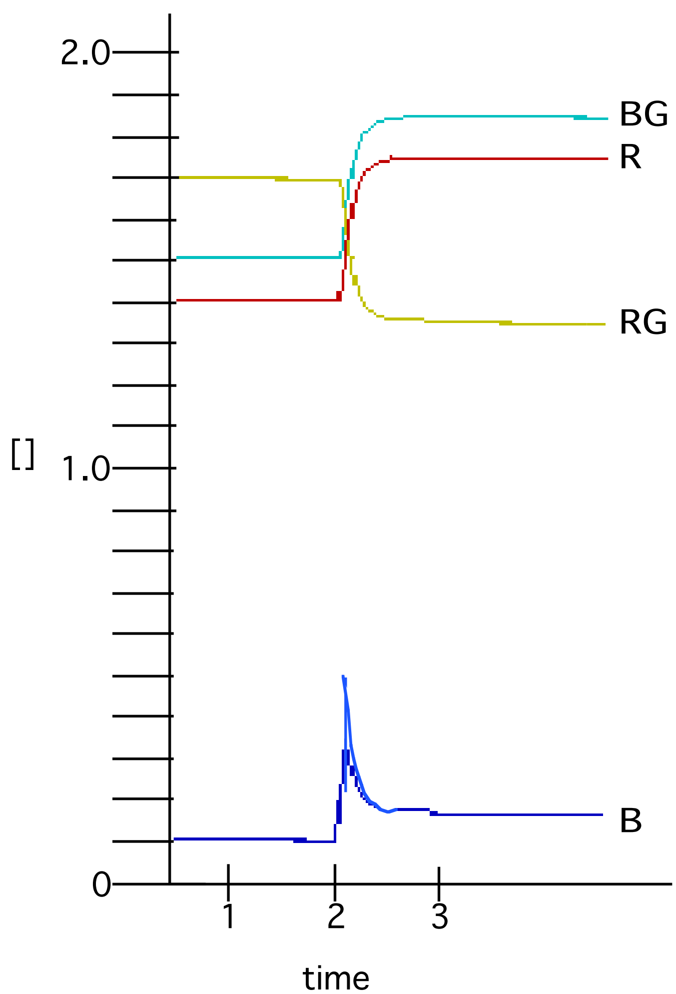
A. Summarize your observations of Experiments #3 - #6 by completing the table below. As an example, the entries for Experiment #2 have been done for you.

Experiment	Stress	Change in [Reactants]	Change in [Products]	Reaction shift
#2	Add reactant [R]	Concentrations decreased	Concentrations increased	Left to Right
#3	**Add reactant [BG]**	**Concentrations decreased**	**Concentrations increased**	**Left to Right**
#4	**Remove reactant [R]**	**Concentrations increased**	**Concentrations decreased**	**Right to Left**
#5	**Add product [RG]**	**Concentrations increased**	**Concentrations decreased**	**Right to Left**
#6	**Remove product [RG]**	**Concentrations decreased**	**Concentrations increased**	**Left to Right**

B. Consider the strip chart recording on the right for a hypothetical experiment.

What was the stress placed on the reaction at time 2?

B was added to the system



Write an equation to describe this reaction, then set up and complete all the entries in an ICE table.

B + RG → R + BG
I : 0.5 1.7 1.4 1.5
C : -0.3 -0.3 +0.3 +0.3
E : 0.2 1.4 1.7 1.8

Also a correct response:

R + BG → B + RG
I : 1.4 1.5 0.5 1.7
C : +0.3 +0.3 -0.3 -0.3
E : 1.7 1.8 0.2 1.4

V. Conclusions:

A. Review the summary of your experimental observations that you prepared in Section IVA. Write a statement(s) that generalizes how stressing a reaction by adding or removing a reactant or product shifts the chemical reaction.

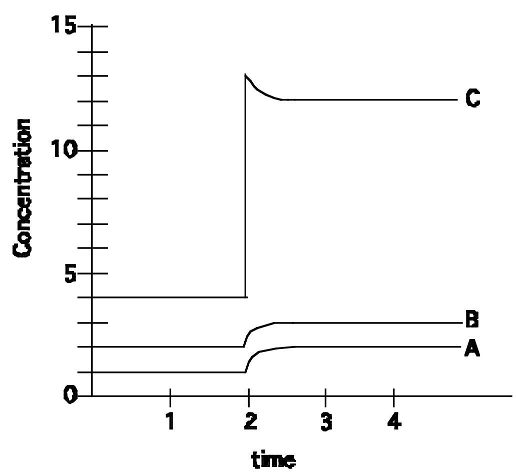
Best Response: When a reaction is disturbed by imposing a stress the reaction will shift in a direction to relieve the stress.

Depending on where you are when you use this experiment, you may or may not have used the term *equilibrium*.

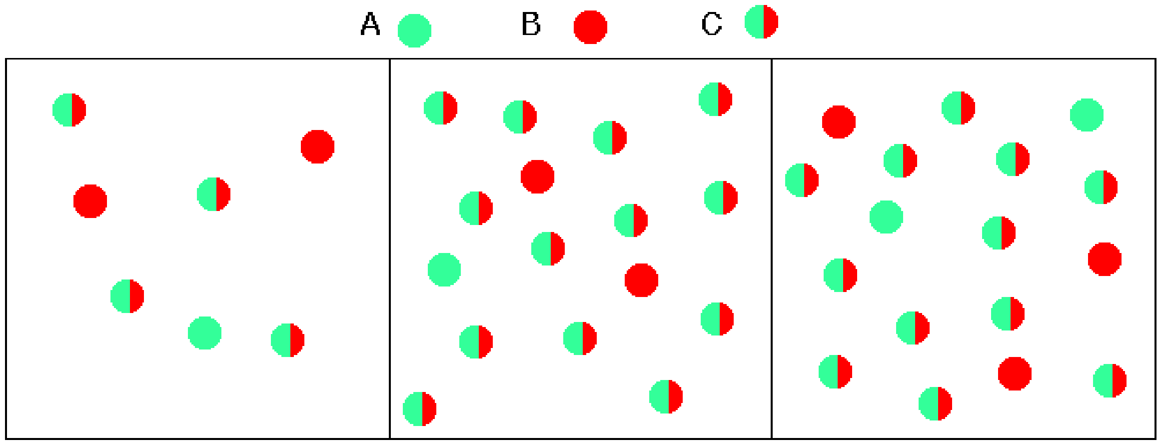
Other Response: When a reaction is disturbed by adding a reactant, or removing a product, the reaction will proceed left to right. When a reaction is disturbed by adding a product, or removing a reactant, the reaction will proceed right to left..

B. Mental Modeling: Consider the strip chart recording on the right for a hypothetical experiment. Write an equation to describe this reaction, then set up and complete all the entries in an ICE table.

	C →	A +	B
I :	**13**	**1**	**2**
C :	**-1**	**+1**	**+1**
E :	**12**	**2**	**3**



In the following boxes, draw pictures at the level of atoms and molecules that represents the progress of the hypothetical experiment from t=1 to t=2 to t=3. Indicate those particles that are added or subtracted from the sample as a result of the stress placed on the system.



time = 1 time = 2 time = 3

If you were to make a drawing for time = 4, how would it be similar to the drawing you made for time = 3? How would it be different?