Name:
Period:

What's So Equal about Equilibrium?

I. True or False?

1. ____ When a process reaches equilibrium, there are no further changes.
2. ____ To show a chemical equilibrium, chemists use a double arrow.
3. ____ Natural and human-generated changes can change the equilibrium in our atmosphere.
4. ____ The stratosphere is warming.
5. ____ Using Le Chatelier's principle, it is easy to predict how the equilibrium of a system will shift in response to changing conditions.

II. Give examples of the following:

1. *Everyday equilibrium*
   a. Dynamic:

   b. Shifting:

2. *Chemical equilibrium*
   a. Dynamic

   b. Shifting:

3. *Atmospheric equilibrium*
   a. Dynamic:

   b. Shifting:

III. The following statements are WRONG. They are misconceptions that students often have. After each misconception, write the correct information or explanation.

1. *"Reactions always go to completion (go all the way to products)."*

2. *"At equilibrium, reactions have equal concentrations of reactants and products."*

3. *"Equilibria are static—particles stop moving when equilibrium is reached."*

4. *"The right and left sides of an equation represent different locations in the container where the reaction is occuring."*

When you are done with the reading and questions, you may choose a partner to complete the following activity.

Equilibrium in Action

Materials (per pair of students)

2 10 ml graduated cylinders

1 small straw (coffee stirrer)

1 large straw

Dropper

Water

Procedure

1. Label the graduated cylinders A and B. One of you will be person A and one person B. Person A will have a large straw, person B will have a small straw.

2. Fill cylinder A with 9 mL of water. B begins empty.

3. Make a chart to record the initial volumes of each cylinder, and then record the volume of each cylinder (without the straw inside) after every transfer.

4. Transfer water from cylinder A to B and from B to A. This is done by lowering the straw to the **bottom** of the cylinder and then placing a finger over the top end. Then lift the straw with the water in it and move it to the other cylinder. When you remove your finger, the water will be released. After releasing your water into the other person's cylinder, return your tube to your own cylinder. One full transfer consists of student A moving one tube of water from cylinder A to B followed by student B transferring one tube of water from B to A. Don't spill, a few drops can really add up.

5. Continue, recording volumes after every transfer, until you believe you have reached equilibrium. *Check with your teacher at this point to make sure!*

6. Once your teacher has verified that you have reached equilibrium, use a dropper to add exactly 2.00 mL of additional (new to the system) water to cylinder A. Record the new volume on your chart, and continue transferring water as before, again reaching equilibrium.

7. Clean your lab area and return to your seat and make a graph of your results on the graph below. Make sure to label all axes, including units. What type of graph would be the best way to represent this data? Provide a descriptive title for your graph. On your graph, label the point where equilibrium is reached and mark the point where you added the additional water.

Questions:

1. Did your system reach equilibrium? If so, use your graph to explain how you could tell. If not, use your graph to predict how many more cycles it would have taken to reach equilibrium.

2. At equilibrium, did the amounts of water in each graduated cylinder equal each other? Did one cylinder get completely "used up"?

3. At equilibrium, if you had continued the activity, would the amount of water in each graduated cylinder have changed significantly over time? EXPLAIN.

4. At equilibrium, if you had continued the activity, would the same exact water molecules have been in each cylinder at all times, or would they have been different water molecules? EXPLAIN.

5. On the same page as your graph, use questions 2-4 above to guide your thinking and explain several ways that a chemical reaction at equilibrium is similar to this activity. (*3 sentence min*.)