Student Directions for: Introduction to **Equilibrium**

Learning Goals: Students will be able to:
- Understand what conditions indicate equilibrium of a system
- Use a physical experiment to model chemical equilibrium
- Sketch how the number of reactants and products will change as a reaction proceeds
- Predict how changing the initial conditions will affect the equilibrium amounts of reactants and products.

PART 1: Done in pairs in class
Materials: 4 beakers: 100 mL and 50 mL and **two** 1000 mL beakers,

Directions: **Read a-e, make an appropriate data table, and then begin.**
a) Label the 1000 ml beakers A and B
b) Put about 700 ml water in the large beaker "A". Leave the other beaker "B" empty.
c) Record the volume of water in the beakers in your table.
d) Transfer water between the large beakers using the following "rules"
- Use the 100 mL beaker to transfer water from A to B;
- Use the 50 mL beaker transfer water from B to A.
- Fill the small beakers as full as possible **without tipping the large beakers** in any way.
- One cycle consists of one A → B transfer and one B → A transfer.
- **For each cycle**, record the volume of water in beakers A and B.
e) Continue cycles and recording the volumes, until the level of water in beakers A and B are **unchanging**.

Analysis:
1. Graph the volumes of water in beakers A and B per cycle.
2. Look up what equilibrium means and describe in your own words how the water exchange is like a system and how the final results demonstrate "equilibrium".
3. What is the ratio of the volume in Beaker B to Beaker A at equilibrium? _____

Experiment 2
4. What do you think would be different and same if the water transfers were repeated with the beaker A initially half full?
5. Repeat the directions a-e above but start with Beaker A with 500 ml and beaker B empty.
   a. Make a table again and then, graph, and state the ratio of B to A to show your results. (like 1-3 of Analysis)
   b. Explain how your ideas from question 4 were supported or need to be corrected.

Experiment 3
6. What do you think would be different and same if the water transfers were repeated with the beaker B initially with 700 ml and beaker A empty?
7. Repeat the directions a-e above but start with Beaker B with 700 ml and beaker A empty.
   c. Make a table again and then, graph, and state the ratio of B to A to show your results. (like 1-3 of Analysis)
   d. Explain how your ideas from question 6 were supported or need to be corrected.

Conclusion:
8. Explain what equilibrium is for a system and how initial conditions effect it.
9. Describe a real-life of an example like a fish tank with male and female fish with some food available could be used to demonstrate system equilibrium.