# Equilibrium

Read from **Lesson 2a** [The Equilibrium State]() in the **Chemistry Tutorial Section, Chapter 14** of **The Physics Classroom**.

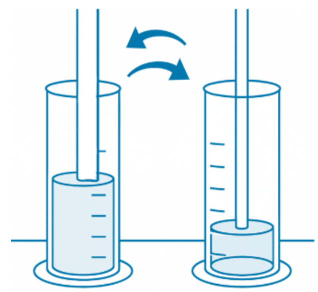
In many chemical reactions, substances don't simply convert from reactants to products and stop. Some reactions are **reversible**, occurring in both the forward and reverse directions. This reversibility is indicated by the symbol ⇄ in a chemical equation, showing that products can re-form into reactants and vice versa.

As the reaction progresses, the concentration of reactants decreases while the concentration of products increases—until both stabilize. This stable state is called **dynamic equilibrium**, where the rates of the forward and reverse reactions are equal.

Although the reaction continues actively at the molecular level, there is no observable change in concentrations. In other words, **dynamic equilibrium means the system is steady—not stopped.**

**Modeling Equilibrium: The Straw Lab**

Crystal Clear and River Bend are conducting the straw equilibrium lab in their chemistry class. In this activity, they use drinking straws to transfer water between two graduated cylinders, observing how the water levels stabilize over time—*just like chemical reactions reaching equilibrium!*



Crystal begins by placing 50.0 mL of water into one graduated cylinder and leaving the second cylinder empty. Crystal then inserts a large straw into the cylinder containing water, while River places a smaller straw into the empty cylinder.

Next comes the "reaction"—a simultaneous water transfer. Crystal and River each touch the bottom of their respective cylinders with their straws and use their fingers to seal the tops. At the same time, they transfer water between cylinders—Crystal moves water from the full cylinder to the empty one using the large straw, and River transfers water in the opposite direction using the small straw.

After each transfer, they record the water levels in the data table shown below. Then, they return the straws to their original cylinders and repeat the transfer process multiple times until the volumes in both cylinders stop changing. To analyze the results, Crystal and River plot a graph of their data. The x-axis represents the number of transfers, and the y-axis represent volumes in milliliters in each graduated cylinder.

Use a graphing app or graph paper to plot both data sets on the same graph. One data set will start at 50.0 mL and the other at 0.0 mL. Connect the sequential data points with straight lines to show two continuous trends.

**Data Table**

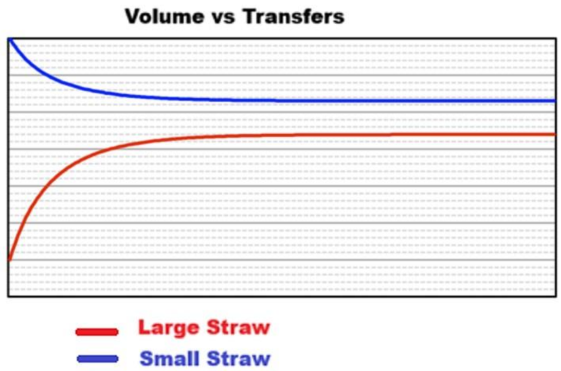
| **Transfers** | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Large Straw** | 50 mL | 41 mL | 35 mL | 30 mL | 25 mL | 21 mL | 20 mL | 18 mL | 16 mL | 16 mL | 16 mL |
| **Small Straw** | 0 mL | 9 mL | 15 mL | 20 mL | 25 mL | 29 mL | 30 mL | 32 mL | 34 mL | 34 mL | 34 mL |

**Kinetics and Equilibrium**

**Questions**

1. Circle the graph that represents the data from this lab.

a.

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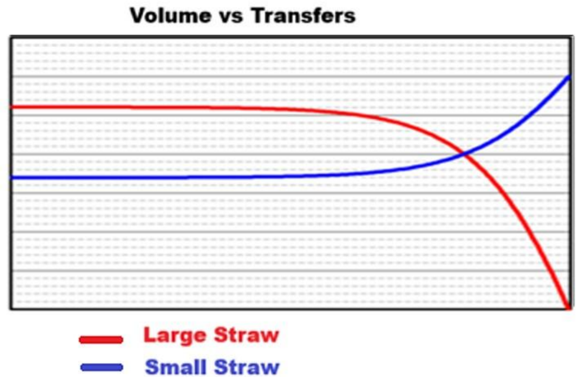


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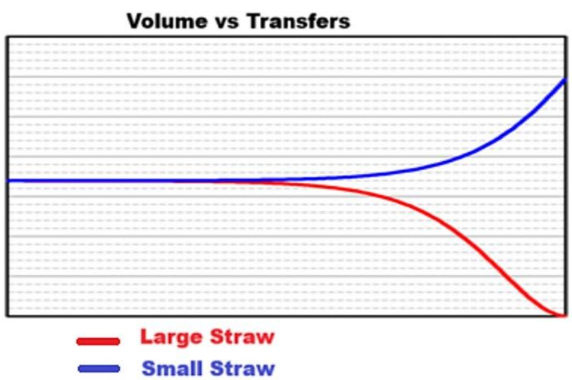


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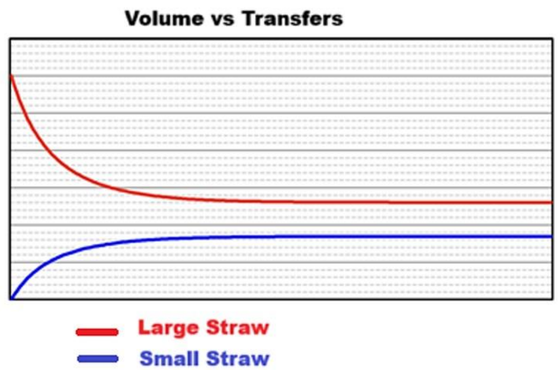


2. In this lab, what does the water represent in terms of a chemical reaction?

3. On your graph, at what point does the system reach equilibrium? How do you know?

4. Based on the data table and graph, what can you conclude about the rates of the forward and reverse reactions once equilibrium is established?

5. Is it correct to say that nothing changes in a system at equilibrium? Why or why not?

6. What are two key characteristics of dynamic equilibrium?