Module 12: Kinetics and Equilibrium
Authentic Assessment: Candy Equilibrium Scientific Investigation

Before you begin the scientific investigation below, make sure to download the *Candy Equilibrium Scientific Investigation Report*. As you complete this scientific investigation, fill in any needed information on the report template. If you need more information about each section of the report, please visit the Developmental module.

Introduction

Equilibrium is defined as the relationship between a pair of opposing chemical reactions. In the reaction, there is a forward and reverse process. In the forward process, the reactants are converted into products. In the reverse process, the products are converted into the reactants. When the rates of both processes are equal, the equilibrium is established. This does not mean that the amounts of the reactants and products are the same. In most cases the reactions will favor either the forward or reverse process. The equilibrium constant, K, is calculated to determine the favorable process. In this scientific investigation, you will observe the "reaction" of various colored candy pieces. It is known to the lovers of candy that the following chemical equilibrium occurs in any cup of candy:

Red + Orange ⇄ 2(Green) + Purple

Objectives

In this scientific investigation, you will:

- relate the properties of chemical equilibrium to a cup of random colored candy.

Hypothesis

Using the **Procedure and Data Collection** section below, read through the procedural information for this scientific investigation. Based on your understanding of the procedure, develop your own hypotheses which describe your expected results. You should consider the following questions: How can a cup of candy explain the rates of reaction? How can a cup of candy be used to calculate the equilibrium constant? Record these hypotheses in the **Hypothesis** section of your *Candy Equilibrium Scientific Investigation Report*.

Equipment and Materials

- Assortment of different colored candies including the colors red, orange, green, and purple (you will need roughly forty of each color)
- 1 large cup or zip close bag

Procedure

1. Mix thirty red and thirty orange candies in the empty large cup or zip close bag.
2. Allow the candies to react by shaking the cup or bag.
3. Randomly remove three candies.
   If you picked;
   a. One red and one orange replace them with two green and one purple. This represents a forward reaction.
   b. Two green and one purple replace them with one red and one orange. This represents a reverse reaction.

   c. Any other combination does not result in a successful reaction. You will need to record "no reaction" in the data table and return the candies to the cup or bag.
4. Repeat Steps 2-3 nine more times. After each reaction, determine the number and concentration of red, orange, green, and purple candies that remain in the cup or bag.
5. Calculate the concentration of each type of candy after each reaction. To calculate the concentration of each candy, divide the amount of each candy by the total number of candies.
6. Create a graph of candy concentrations on the y-axis versus reaction number on the x-axis. Keep this graph current as your repeat the reactions. This graph will help you determine when equilibrium is reached. The graph will have a different line for each of the four candy colors.
7. Continue steps one through six until the hypothetical reaction has reached equilibrium.

Data

Record any observations and data on the data table provided in the **Data** section of your *Candy Equilibrium Scientific Investigation Report*. The data table is also shown below.

	Amount of Each Colored Candy						Concentration of Each Colored Candy			
	Red	Orange	Green	Purple	Total Candy	Type of Reaction	Red	Orange	Green	Purple
0	30	30	0	0	60	-	0.5	0.5	0	0
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										

Data Analysis

In the **Data Analysis** section of your *Candy Equilibrium Scientific Investigation Report*, provide the answers to the following questions:

1. Using your graph and data, how did you know when your reaction reached equilibrium?
2. At the equilibrium point, calculate the equilibrium constant for the reaction. Make sure that you show all of your work.
3. What does the equilibrium constant tell you?
4. How could you determine the rate of reaction by analyzing the graph?

Conclusion

Using the **Conclusion** section of your *Candy Equilibrium Scientific Investigation Report*, compose three to four sentences describing an overall conclusion about the results of the experiment. Base your conclusions on your data. Were your hypotheses true or false, and how do you know? Use the data and notes that you collected from your experiment to form your conclusion. Make sure that your include information that your gained from data analysis to support your conclusion.

Experimental Sources of Error

On your *Candy Equilibrium Scientific Investigation Report*, provide responses to the following questions: Are there any sources of error? If so, what are they, and what could be done to minimize error?

Once you have completed the *Candy Equilibrium Scientific Investigation Report*, please submit your work to the dropbox.