Candy Equilibrium Lab

Introduction

Equilibrium is the relationship between a pair of opposing chemical reactions. In the reaction A↔B there is a forward reaction where A is converted into B and a reverse reaction where B is converted into A. When the two rates are equal (meaning when A is converted into B as often as B is converted into A), equilibrium between the two reactions has been established. This does not mean that the amount of A equals the amount of B! In fact, one reaction often will have occurred more frequently before this equilibrium is reached, resulting in an excess of either the reactants or the products.

The equilibrium constant, or Keq, is used to tell whether the reactants or products are favored for a given chemical reaction at a given set of conditions.

Lets look at the reaction: $aA + bB \leftrightarrow cC + dD$

The equilibrium constant for this reaction is:

$$Keq = \frac{[\text{concentration of products}]}{[\text{concentration of reactants}]} = \frac{[C]^c[D]^d}{[A]^a[B]^b}$$

In this lab, we will be studying an analogy to chemical equilibrium- the "reaction" of various colored candy pieces. It is well known to most candy-lovers that the following chemical equilibrium occurs in a cupful of candy:

Red + Orange ↔ 2 Green + Purple

R + O ↔ 2 G + P

Procedure

1. Mix 30 red candies and 30 orange candies into an empty cup
2. Record the starting numbers and concentrations for the reactants and products in your data table as trial 0
3. Allow the candies to react by shaking the cup and picking out three candies (This represents a collision between these three candies, possibly leading to a chemical reaction.)
4. If you picked;
    a. At least 1 red & 1 orange, replace them with 2 green & 1 purple (and return the extra candy to the cup because it did not react) What type of reaction occurred forward or reverse? Record the information in your data table
    b. 2 green & 1 purple, replace them with 1 red & 1 orange. What type of reaction occurred forward or reverse? Record the information in your data table
    c. Any other combination does not result in a successful reaction, so you have "no reaction" and none of the concentrations change. Record the information in your data table and return the candies to your cup.
5. After each reaction, determine the number and concentration of red, orange, green, and purple candies that remain in the cup. Be sure to record your information in your data table.
6. Perform another reaction by shaking the cup and picking another 3 candies. Record the data (refer to step 4 and 5).
7. Continue until the reaction reaches equilibrium. (Hint: How will you know when you have reached equilibrium? What should you see if you look at the last ten reactions?)
8. Dispose of all chemicals according to lab safety guidelines and return the cups.

Data

1. Record your data in the provided data sheet! Be sure to record the data for *EACH* collision (each time you pick three candies), even those that do not result in a forward or reverse reaction!

Graphing & Calculations

1. To calculate the concentration of each type of candy = $\frac{\text{(total number candies of one color)}}{\text{(total number of candies)}}$
2. Be sure to record the concentration calculations in your data table
3. On a sheet of graph paper set up a graph with candy concentrations on the y-axis and time (the reaction number) on the x-axis.
4. Your graph should have four different lines for four different candy colors! Be sure to keep track of your data! (using colors while graphing should help!)

Chemist: _____

Period: _____ Date: _____

Candy Equilibrium Lab

Purpose

Data: *Be sure to include completed data table & graph!*

Analysis & Conclusion

1. Looking at your graph and data, how did you know when your reaction reached equilibrium?

2. Calculate the equilibrium constant for your reaction. Show your work and explain how you selected the data to analyze! (*Hint: Look at the introduction*)

3. What determines when equilibrium is reached? What is about the same when equilibrium is reached?

4. What does the value of the equilibrium constant tell you?

    a. What can you conclude about the concentration of reactants and products if the equilibrium constant is greater that one?

    b. What can you conclude about the concentration of reactants and products if the equilibrium constant is less that one?

5. How can you assess the rate of the reactions by looking at the graph? What aspect of the graph do you need to look at?

    a. What can you conclude about the rate of the reaction as you moved from time zero to equilibrium? Explain this on the molecular, or candy, level.

6. What would happen if we added 30 additional reds and 30 additional oranges after your candy reaction reached equilibrium?

7. What would happen if we added 60 additional green and 30 additional purples after your candy reaction reached equilibrium?

Be sure to record every collision, every time you pick 3 candies out, even if no reaction occurs!

Time (reaction #)	#R	#O	#G	#P	Total candies (R+O+G+P)	Type Fwd / Rvs / noRxn	[R] #R/ total candies	[O] #O/ total candies	[G] #G/ total candies	[P] #P/ total candies
0	30	30	0	0	60	-	0.5	0.5	0	0
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Time (reaction #)	#R	#O	#G	#P	Total candies (R+O+G+P)	Type Fwd / Rvs / noRxn	[R] #R/ total candies	[O] #O/ total candies	[G] #G/ total candies	[P] #P/ total candies
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