The Kinetics of a Bleach Reaction 2

The primary objective of this experiment is to determine the rate law and order of a reaction between food coloring and commercial bleach. You will use a Vernier Spectrometer or a Vernier SpectroVis to measure the absorbance of the reaction over time. You will first measure the absorbance of a food coloring solution over the visible light spectrum and identify the wavelength of maximum absorbance (λ max) to examine during the reaction. As the reaction between the food coloring and bleach proceeds, the food coloring will fade and the absorbance will decrease.

You will determine the order of the reaction and write the rate law based on your analysis of the graph of absorbance *vs*. time.

OBJECTIVES

In this experiment, you will

- Measure and analyze the visible light absorbance spectrum of a food coloring solution to determine the maximum wavelength of absorbance.
- Measure the absorbance of the reaction between a food coloring solution and bleach.
- Analyze the absorbance *vs*. time graphs to determine the order of the reaction.
- Write the rate law for the reaction.

MATERIALS

Vernier Spectrometer or SpectroVis
computer
Vernier Logger *Pro* 3 software
pipet pump or pipet bulb
one cuvette
250 mL beaker
100 mL beaker
food coloring
commercial bleach (5.25% OCl^-)
distilled water
plastic Beral pipet
stirring rod
tissues (preferably lint-free)
10 mL graduated cylinder

PROCEDURE

1. Obtain and wear goggles.

2. Use a USB cable to connect a Vernier Spectrometer or SpectroVis to a computer.

3. Start Logger *Pro* 3 (version 3.6 or newer) on your computer.

4. Measure out 100 mL of distilled water into a 250 mL beaker. Add two drops of green food coloring to the beaker of distilled water and mix thoroughly. Measure out 10 mL of bleach and set it aside until Step 7.

© 2007 Vernier Software & Technology

5. Calibrate the spectrometer.
   a. Prepare a *blank* by filling an empty cuvette ¾ full with distilled water. Place the blank cuvette in the spectrometer.
   b. Select Calibrate ► Spectrometer from the Experiment menu. The calibration dialog box will display the message: "Waiting …seconds for lamp to warm up." The minimum warm up time is 90 seconds. Follow the instructions in the dialog box to complete the calibration. Click OK.
6. Determine the maximum wavelength for the food colored solution and set up the mode of data collection.
   a. Empty the blank cuvette and rinse it twice with small amounts of the food colored solution. Fill the cuvette ¾ full with the solution and place it in the spectrometer.
   b. Click Collect. A full spectrum graph of the solution will be displayed. Note that one area of the graph contains a peak absorbance, and there may be other lesser peaks that characterize this substance. Click Stop to complete the analysis.
   c. To save your graph of absorbance *vs*. wavelength, select Store Latest Run from the Experiment menu.
   d. Click the Configure Spectrometer Data Collection icon,  , on the toolbar. A dialog box will appear.
   e. Select Absorbance *vs*. Time under Set Collection Mode. The wavelength of peak absorbance (λ max) is automatically selected. You can select a different wavelength by clicking on the graph or checking the box next to the desired wavelength. Click OK.
7. Collect absorbance-time data for the reaction of food colored solution and bleach.
   a. Remove the cuvette from your spectrometer and pour out the solution. Rinse the cuvette twice with ~2 mL portions of distilled water.
   b. DO THIS QUICKLY: Add the 10 mL of bleach to the beaker of food coloring solution. Swirl the reaction mixture with a plastic Beral pipet and use the pipet to fill the cuvette ¾ full of the reaction mixture. Place the cuvette in the spectrometer.
   c. Click Collect. Absorbance data will be plotted every second for 200 seconds.
   d. You can allow the data collection to run to completion, or you can click Stop to halt the data collection before the 200 second run time.
   e. Discard the cuvette contents as directed.
   f. Examine the graph of absorbance *vs*. time, showing a gradual decrease in absorbance. To save your graph, select Store Latest Run from the Experiment menu.
   g. Repeat the procedure to conduct a second trial with a new food colored solution and another 10 mL sample of bleach.
8. (optional) Select Save As… from the File menu and save your experiment file.

© 2007 Vernier Software & Technology

DATA ANALYSIS

1. Use your results to determine the order of the reaction. Consider the bleach to be in excess.

2. Use the format: rate = $k[FC]^x$ to write a rate law for the reaction. [FC] denotes the concentration of the food colored solution. Substitute the appropriate digit for the value of x in the rate law. Calculate a value for the rate constant, k.

3. Determine the rate of the reaction during the first ten seconds.

4. How many seconds had passed before the food coloring concentration decreased by half?

© 2007 Vernier Software & Technology