Name: _____ Period: _____

Kinetics of the Bleaching of Crystal Violet with Sodium Hydroxide

Introduction:

In Part 1 of the investigation, you will prepare dilutions of a stock CV solution to generate a Beer's law calibration curve for CV. In Part 2 of the investigation, you will perform a reaction of CV with NaOH while monitoring the concentration of CV remaining over time.

Net Ionic Equation of Reaction: $CV^{+}_{(aq)} + OH^{-}_{(aq)} \rightarrow CVOH_{(aq)}$

Rate Law: $\text{rate} = k\,[CV^{+}]^{x}\,[OH^{-}]^{y}$

Background:

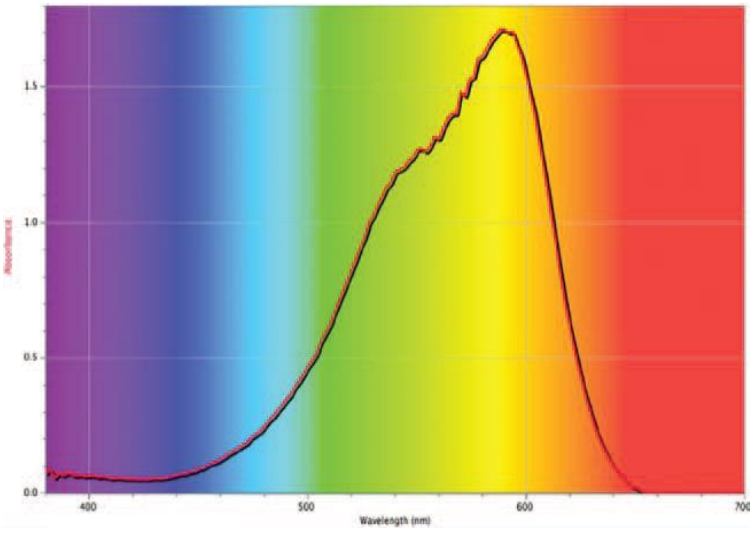
If you're making something, you might think making it to last would always be a good thing. But what if you're making a pesticide with known detrimental impacts on human health? Then you may only want it to stay intact for a few days after it has been applied to crops before it decomposes into what often are less harmful products. If its molecules stay intact for too long, the pesticide can persist in the environment and build up in drinking water. In 2000, over 20 million kilograms of the pesticide 1,3-dichloropropene (1,3-D) were applied to crops in the United States. Scientists investigated the rate of decomposition of 1,3-D in acidic, basic, and neutral solutions as well as in soil. For each case, they generated plots of the amount of intact 1,3-D persisting versus time and found that the reaction could be characterized as pseudo first-order. Knowing the order of the reaction allowed them to determine the half-life of intact 1,3-D. In acidic media, they found that the half-life for the decomposition of 1,3-D was about eight days, but in the presence of excess NaOH the half-life was reduced to about four days. Experimentally determined data like this is vital to the ability of society to use chemicals wisely in improving food production, while not endangering the end consumers or the people who work with the chemicals during the growing process.

Materials

25.0 μ*M* crystal violet solution
Distilled water
Transfer pipettes
Spectrophotometer
10 mL graduated cylinder
0.020 *M* sodium hydroxide (NaOH) solution
Cuvettes for spectrophotometer

Pre-Lab Questions:

1. Based on the absorption spectrum of 25 μ*M* crystal violet in the figure below and taking into account the considerations that follow, what wavelength should you use for the Beer's law calibration curve and subsequent reaction of CV with NaOH? Explain your answer. Two main factors to consider, working in opposition to each other, are sensitivity and range. These instruments are typically not sensitive enough to reliably measure absorbance values much above 1.0 absorbance units. The absorbance at the chosen wavelength should be high enough that it can vary over a wide range of values during the reaction.



2. What is Beer's law? Write the equation and define the variables.

3. Why is a calibration curve necessary? What is its purpose?

4. A calibration curve requires the preparation of a set of known concentrations of CV, which are usually prepared by diluting a stock solution whose concentration is known. Calculate the volumes needed to prepare 10.0 mL of different µ*M* CV solution using a 25 µ*M* CV stock solution. Show work for one of the dilutions. Fill in the table with the appropriate amounts for each diluted concentration.

CV concentration (µM)	**Volume of stock CV (mL)**	**Volume of water added (mL)**

Show your work for one dilution below and fill in the table above.

5. During the reaction of CV with NaOH, do you expect the spectrophotometer's absorbance reading to change? How do you expect it to change if such a change is anticipated (i.e., increase, decrease, or no change) as the reaction proceeds? Explain your reasoning.

Procedure:

Part 1: The Collection of Experimental Data to Generate a Calibration Curve

1. Turn on the spectrophotometer and allow it to warm up for 15 – 20 minutes before use. Adjust the wavelength setting to the optimum wavelength or set the spectrophotometer to 565 nm.
2. Prepare the standard dilutions of the crystal violet stock solution. Use the amounts calculated in the pre-lab. Mix thoroughly.
3. Measure and record the absorbance of the stock solution and each standard solution (dilution) at the selected wavelength.
4. Construct a calibration curve of absorbance vs. concentration for crystal violet.

Part 2: Rate of Reaction of Crystal Violet with Sodium Hydroxide

1. Set the spectrophotometer to 565 nm and zero the instrument using a blank of equal volumes of DI water and 0.020 M NaOH.
2. Measure 10.0 mL of 25 um crystal violet in a pipette and add it to a clean 50 mL beaker. Rinse the pipette with distilled water several times and also with the sodium hydroxide solution. Measure 10.0 mL of 0.020 M sodium hydroxide in a pipette.
3. Add the sodium hydroxide into the 50 mL beaker with crystal violet. Mix and immediately begin timing.
4. Transfer the reacting solutions to a cuvette and clean the outside with a lint-free wipe. Place into the spectrophotometer and close the lid. Record absorbance measurements every 20 seconds for 10 minutes.

Required sections:

Title
BQ (for part 2 only)
Variables (part 1 and part 2)
Safety
Procedures (part 1 and part 2)
Data, observations, calculations, graphs (part 1 and part 2)
Claims (part 2)
Evidence and reasoning (part 2)
Errors and improvements
Reflection
Presentation

Data: What qualitative and quantitative data should be gathered?

Part 1 – Calibration curve

Part 2 – Rate of reaction

Calculations: What calculations need to be performed?

Part 1 – Calibration curve

Part 2 – Rate of reaction

Graphs: What graphs need to be included (hand-drawn)?

Part 1 – Calibration curve

Part 2 – Rate of reaction