Graphical Analysis 25

The Rate and Order of
a Chemical Reaction

A basic kinetic study of a chemical reaction often involves conducting the reaction at varying concentrations of reactants. In this way, you can determine the order of the reaction in each species, and determine a rate law expression. Once you select a reaction to examine, you must decide how to follow the reaction by measuring some parameter that changes regularly as time passes, such as temperature, pH, pressure, conductance, or absorbance of light.

In this experiment you will conduct the reaction between solutions of potassium iodide and iron (III) chloride. The reaction equation is shown below, in ionic form.

2 I– (aq) + 2 Fe3+ (aq) → I2 (aq) + 2 Fe2+ (aq)

As this reaction proceeds, it undergoes a color change that can be precisely measured by a Colorimeter. By carefully varying the concentrations of the reactants, you will determine the effect each reactant has on the rate of the reaction, and consequently the order of the reaction. From this information, you will write a rate law expression for the reaction.

PRELAB

Add this lab to your table of contents

Write a purpose for this lab

Create a table of reagents including all hazard warnings

Calculate the concentration of the 5 solutions created in step 7, and fill them into the data table

OBJECTIVES

* Conduct the reaction of KI and FeCl3 using various concentrations of reactants.
* Determine the order of the reaction in KI and FeCl3.
* Determine the rate law expression for the reaction.



Figure 1

MATERIALS

Chromebook, computer, or mobile device

Graphical Analysis 4 app

Go Direct Colorimeter

100 mL beaker

three 50 mL graduated cylinders

five plastic Beral pipets

plastic cuvettes

0.020 M potassium iodide, KI, solution

0.020 M iron (III) chloride, FeCl3, solution, in 0.10 M HCl

distilled water

PROCEDURE

1. Obtain and wear goggles.
2. Obtain the materials you will need to conduct this experiment.
	* Three 50 mL graduated cylinders
	* 100 mL beaker
	* Approximately 100 mL of 0.020 M KI solution in a 250 mL beaker Potassium iodide, 0.5 M, KI: This chemical is considered nonhazardous according to GHS classifications. Treat all laboratory chemicals with caution. Prudent laboratory practices should be observed.
	* Approximately 100 mL of 0.020 M FeCl3 solution in a separate 250 mL beaker DANGER: Iron(III) chloride hexahydrate, Fe(III)Cl3: Causes severe skin and eye burns and damage. Harmful if swallowed or inhaled. Do not eat or drink when using this product. Do not breathe mist, vapors, or spray.
	* distilled water
3. Prepare a blank by filling a cuvette 3/4 full with distilled water. To correctly use cuvettes, remember:
	* Wipe the outside of each cuvette with a lint-free tissue.
	* Handle cuvettes only by the top edge of the ribbed sides.
	* Dislodge any bubbles by gently tapping the cuvette on a hard surface.
	* Always position the cuvette so the light passes through the clear sides.
4. Launch Graphical Analysis. Connect the Colorimeter to your Chromebook, computer, or mobile device.
5. Calibrate the Colorimeter.
	1. Open the Colorimeter lid, insert the blank, and close the lid.
	2. Press the < or > button on the Colorimeter to select the wavelength of 430 nm (Blue). Press the CAL button on the Colorimeter. When the LED stops flashing, the calibration is complete. Remove the cuvette from the Colorimeter and save it for Step 8.
6. Set up the data-collection mode.
	1. Click or tap Mode to open Data Collection Settings.
	2. Change Rate to 1 samples/s and End Collection to 200 s. Click or tap Done.
7. During this experiment you will conduct 5 trials of the reaction between 0.020 M KI and 0.020 M FeCl3, using the volumes of liquids described in the table below.

|  |  |  |  |
| --- | --- | --- | --- |
| Trial | FeCl3 (mL) | KI (mL) | H2O (mL) |
| 1 | 20.0 | 20.0 | 0.0 |
| 2 | 20.0 | 10.0 | 10.0 |
| 3 | 10.0 | 20.0 | 10.0 |
| 4 | 15.0 | 10.0 | 15.0 |
| 5 | 10.0 | 15.0 | 15.0 |

1. Conduct Trial 1.
	1. Measure 20.0 mL of FeCl3 solution into a 100 mL beaker.
	2. Measure 20.0 mL of KI solution using a different graduated cylinder and add into the 100 mL beaker with the FeCl3, Swirl the beaker to mix.
	3. Rinse the cuvette twice with ~1-mL amounts of the reaction mixture, fill it 3/4 full, and place it in the device. Close the lid.
2. Click or tap Collect to start data collection. Observe the progress of the reaction. Absorbance data will be collected for 200 seconds. You may click or tap Stop to stop data collection early if desired.
3. When data collection is complete, carefully remove the cuvette from the device. Dispose of the contents of the beaker and cuvette as directed. Rinse and clean the beakers and the cuvette for the next trial.
4. Examine the graph of the first trial. Select data in the first minute of data collection to analyze (for example, from 20 seconds to 50 seconds). Click or tap Graph Tools, , and choose Apply Curve Fit. Select Linear as the curve fit. Click or tap Apply. Record the slope, as the initial rate of the Trial 1 reaction, in your data table. Note the time region that you selected; this same region should be used for all remaining trials. Dismiss the Linear curve fit box.
5. Repeat Steps 8–11 to conduct Trials 2–5 using the information in the table. Note: The previous data set is automatically saved. It works well to add the distilled water to the beaker of KI solution before adding the FeCl3 solution. Use the same region of the graph to calculate the initial rates for Trials 2–5 that you used in Trial 1.

DATA TABLE

|  |  |  |  |
| --- | --- | --- | --- |
| Trial | [FeCl3] | [KI] | Initial rate (s–1) |
| 1 |   |   |   |
| 2 |   |   |   |
| 3 |   |   |   |
| 4 |   |   |   |
| 5 |   |   |   |

DATA ANALYSIS

1. What is the order of the reaction in FeCl3 and KI? Explain.
2. Write the rate law expression for the reaction.
3. Is it possible to calculate the rate constant, k, from your data? If so, calculate the rate constant. If not, explain why not.