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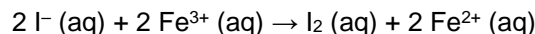
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Introduction

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.



As this reaction proceeds, it undergoes a color change that can be precisely measured by a Vernier Colorimeter or a Vernier Spectrometer. 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.

Objectives

In this experiment, you will

- 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.

Materials

Chemicals

- 0.02 M Potassium Iodide, KI solution
- 0.020 M Iron(III) Chloride, FeCl₃ in 0.10 M HCl
- Distilled water

Equipment

- Computer
- Vernier computer interface*
- Logger Pro
- Colorimeter or Spectrometer
- 250 mL beakers x3

- 100 mL beakers x2
- 25 mL graduated cylinders x3
- Plastic cuvettes
- Plastic Beral pipets x5
- *no interface required if using a Spectrometer



SAFETY PRECAUTIONS

The FeCl₃ solution in this experiment is prepared in 0.1 M HCl and should be handled with care.


Procedure

Both Colorimeter and Spectrometer Users

- 1) Obtain and wear goggles.
- 2) Obtain the materials you will need to conduct this experiment.
 - Three 25 mL graduated cylinders
 - Three 100 mL beakers
 - Approximately 100 mL of 0.020 M KI solution in a 250 mL beaker
 - Approximately 100 mL of 0.020 M FeCl₃ solution in a separate 250 mL beaker
 - Approximately 60 mL of distilled water in a third 250 mL beaker
- 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.

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Spectrometer Users Only (Colorimeter users proceed to the Colorimeter section)

- 4) Use a USB cable to connect the Spectrometer to the computer. Choose New from the File menu.
- 5) To calibrate the Spectrometer, place the blank cuvette into the cuvette slot of the Spectrometer, choose Calibrate → Spectrometer from the Experiment menu. The calibration dialog box will display the message: “Waiting 60 seconds for lamp to warm up.” After 60 seconds, the message will change to “Warmup complete.” Click .
- 6) Determine the optimal wavelength for the FeCl₃ solution and set up the mode of data collection.
 - a) Empty the blank cuvette and rinse it twice with small amounts of 0.020 M FeCl₃ solution. Fill the cuvette about 3/4 full with the FeCl₃ solution and place it in the spectrometer.
 - b) Click . The absorbance vs. wavelength spectrum will be displayed. Note that one area of the graph contains a peak absorbance. Click .
 - c) To save your graph of absorbance vs. wavelength, select Store Latest Run from the Experiment menu.
 - d) To set up the data collection mode and select a wavelength for analysis, click on the Configure Spectrometer Data Collection icon, , on the toolbar.
 - e) Click Abs vs. Time (under the Set Collection Mode). The wavelength of maximum absorbance (λ max) will be selected. Click . Remove the cuvette of FeCl₃ solution from the spectrometer and dispose of the FeCl₃ as directed. Save the cuvette for Step 8.

Colorimeter Users Only

- 4) Connect the Colorimeter to the computer interface. Prepare the computer for data collection by opening the file “25 Rate and Order” from the *Advanced Chemistry with Vernier* folder of *Logger Pro*.
- 5) Open the Colorimeter lid, insert the blank, and close the lid.
- 6) To calibrate the Colorimeter, press the < or > button on the Colorimeter to select the wavelength of 430 nm (Blue). Press the CAL button until the red LED begins to flash and then release the CAL button. When the LED stops flashing, the calibration is complete.

Both Colorimeter and Spectrometer Users


- 7) During this experiment you will conduct 5 trials of the reaction between KI and FeCl₃, using the volumes of liquids described in the table below.

Trial	FeCl ₃ (mL)	KI (mL)	H ₂ O (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

- 8) Conduct Trial 1.
 - a) Measure 20.0 mL of FeCl₃ solution into a 100 mL beaker.
 - b) Measure 20.0 mL of KI solution into a second 100 mL beaker.
 - c) Add the 20.0 mL of FeCl₃ solution to the beaker of KI solution. Swirl the beaker to mix.
 - d) Rinse the cuvette twice with ~1-mL amounts of the reaction mixture, fill it 3/4 full, and place it in the device (Colorimeter or Spectrometer). Close the lid of the Colorimeter.
- 9) Click . The default settings are 1 sample per second for 200 seconds. You may click to end the data collection early. Observe the progress of the reaction.
- 10) When the 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.

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- 11) Examine the graph of the first trial. Select a **linear region in the first minute** of the data collection to analyze (for example, from 20 seconds to 50 seconds). Click the Linear Regression button, . Record the slope, as the initial rate of the Trial 1 reaction, in your data table and then close the Linear Regression box.
- 12) Repeat Steps 8–11 to conduct Trials 2-5. 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.

Disposal and Cleanup

Your teacher will provide disposal and cleanup instructions.

Data Table

Trial	[FeCl ₃]	[KI]	Initial rate (s ⁻¹)
1			
2			
3			
4			
5			

Calculations and Post Lab Discussion Questions (All in one section this time)

Record all values into your Data Table. Answer as part of your post lab. Do not recopy the questions, just paraphrase them into your answer so the reader can infer what the question was.

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