

THE RATE AND ORDER OF A CHEMICAL REACTION

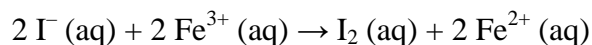
LAB ADV COMP 25

From *Advanced Chemistry with Vernier*, Vernier Software & Technology, 2004

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 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

Vernier computer interface
computer
Vernier V Spec
plastic cuvettes
five plastic Beral pipets

0.020 M potassium iodide, KI, solution
0.020 M iron (III) chloride, FeCl₃, solution
distilled water
three 25 mL graduated cylinders
two 100 mL beakers



PROCEDURE

1. Obtain and wear goggles.
2. Connect a V-Spec to the computer with the proper cable.

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3. Start the *Logger Pro* program on your computer. Open the file “25 Rate and Order” from the *Advanced Chemistry with Vernier* folder.
4. Set up and calibrate the V-Spec.
 - a. Select connect interface → spectrometer → scan for spectrometer from experiments menu
 - b. Choose calibrate → spectrometer from experiment menu. The calibration dialog box will appear. Allow spectrometer to warm up for 3 minutes. Follow instructions in box to complete the calibration
5. Conduct the reactions according to the chart below. Use graduated cylinders to measure out the volumes of reactants and distilled water. Add the distilled water to the KI solution, to standardize your process. Place the two reactants in separate beakers.

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

6. Prepare for Trial 1 and collect absorbance data.
 - 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. Remove the cuvette from the Colorimeter and pour out the distilled water.
 - d. Add the 20.0 mL of FeCl₃ solution to the beaker of KI solution. Swirl the beaker to mix.
 - e. Rinse the cuvette twice with ~1-mL amounts and then fill it $\frac{3}{4}$ full. Wipe the outside of the cuvette with a tissue, place it in the Colorimeter, and close the lid.
7. Click configure data collection icon. Click abs v time. Set wave length at right of box by checking 430 nm.
8. Click  Collect to begin collecting absorbance data. Data will be gathered for 2 minutes. Observe the progress of the reaction in the beaker.
9. When the data collection is complete, carefully remove the cuvette from the Colorimeter. Dispose of the contents of the beaker and cuvette as directed. Rinse and clean the beakers and the cuvette for the next trial.
10. Examine the graph of the first trial. Select a linear region of the graph that covers about 30-40 seconds of the reaction. Click the Linear Regression button, . Record the slope, as the initial rate of the Trial 1 reaction, in your data table.
11. Repeat Steps 6-9 to conduct Trials 2-5. **Note:** You will skip Step 6c in Trials 2-5.

DATA TABLE

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

DATA ANALYSIS

1. Calculate the molar concentration of FeCl₃ and KI for each reaction and record the values in the table above. Provide one example to show how you completed the calculation.
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.