

Name _____

Section _____ Date _____

101 Experiment #5
STOICHIOMETRIC RELATIONSHIPS BETWEEN
REACTANTS AND PRODUCTS

Chemicals Needed:

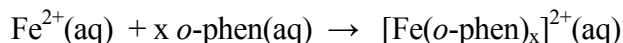
Solutions of iron(II) sulfate and *o*-phenanthroline (*o*-phen).

Safety and Waste Disposal:

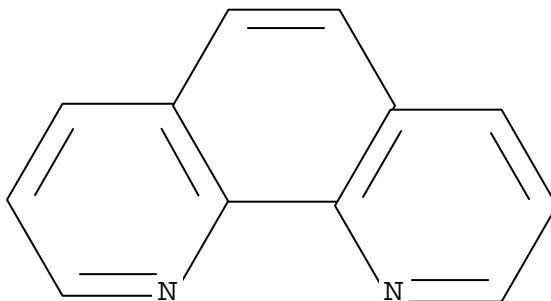
All solutions must be disposed of in the appropriate container in the hood. Pour nothing down the drain.

Introduction:

Chemical stoichiometry is the relationship between the quantity (mass or moles) of products and reactants. In this laboratory experiment, this relationship will be evaluated by reacting a constant amount of one reagent, *o*-phenanthroline, with a varying amount of a second reagent, $\text{Fe}^{2+}(\text{aq})$, according to the reaction:



The $\text{Fe}^{2+}(\text{aq})$ is supplied by using the compound ferrous ammonium sulfate hexahydrate, $\text{Fe}(\text{NH}_4)_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$. *o*-Phenanthroline, which in this case is called a Lewis base or a ligand, has the chemical formula $\text{C}_{12}\text{H}_8\text{N}_2$ and the chemical structure:



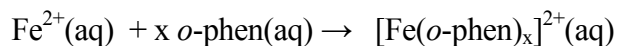
Each *o*-phenanthroline molecule binds to the Fe^{2+} ion by the two nitrogen atoms. In order to determine the chemical stoichiometry of this reaction, we must know the amount of product formed. This will be accomplished by measuring the quantity of light absorbed (called **absorbance**) by the product. In this experiment, the absorbance of the solution is directly proportional to the concentration of the product, $[\text{Fe}(o\text{-phen})_x]^{2+}$, in the solution:

Absorbance (A) \propto Concentration of Product

$$A \propto C$$

Before beginning the experiment, suggest a hypothesis as to the relationship between the quantity of $\text{Fe}^{2+}(\text{aq})$ added and the quantity of product obtained.

Chemical Reaction:



Hypothesis: _____

Procedure:

PLEASE NOTE: You and your laboratory partner will be one group. It is very important that you carry out your portion of the experiment carefully as the class results will not be meaningful if your results are incorrect. Each laboratory group will carry out the experiment twice, adding different volumes of the iron(II) solution to a constant amount (10 mL) of *o*-phenanthroline. Your Instructor will tell you the two amounts of iron(II) solution to use.

Group Number _____

mL of iron(II) solution to add to *o*-phen

Trial #1 _____ Trial #2 _____

The concentration of ferrous ammonium sulfate hexahydrate, $\text{Fe}(\text{NH}_4)_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$, is 62 mg/L and that of the *o*-phenanthroline, $\text{C}_{12}\text{H}_8\text{N}_2 \cdot \text{H}_2\text{O}$, is 113 mg/L.

Calculate the molarity (moles/L) of each reagent.

Molarity of $\text{Fe}(\text{NH}_4)_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$ _____ M

Molarity of *o*-phen _____ M

Burets containing the iron(II) solution and the *o*-phenanthroline solution have been set-up in the laboratory. Obtain a 50-mL volumetric flask, wash thoroughly, then rinse with deionized water. Record the initial buret reading for the two solutions in the Data section below. Add exactly 10 mL of the *o*-phenanthroline solution to the 50-mL volumetric flask, then add the amount of iron(II) solution for Trial #1 to the same volumetric flask. Record the Final Buret Reading for both solutions in the Data section below. Swirl the mixture gently, then dilute to the mark with deionized water, cap, and invert the flask ten times to mix completely.

Take the solution to your Instructor and measure the absorbance of this solution. Record the absorbance (A) for Trial #1 in the Data section below.

Pour this solution into the container in the hood. Rinse the volumetric flask three times with deionized water, then repeat the procedure above, using the amount of iron(II) solution for Trial #2. Record all measurements in the Data section below.

Rinse all glassware with deionized water and return the volumetric flask to the laboratory bench.

<u>Data:</u>	<u>Trial #1</u>	<u>Trial #2</u>
Iron(II) Solution		
Final Buret Reading	_____	_____
Initial Buret Reading	_____	_____
mL Added	_____	_____
<i>o</i> -Phenanthroline		
Final Buret Reading	_____	_____
Initial Buret Reading	_____	_____
mL Added	_____	_____
Absorbance of Final Solution	_____	_____

Record your mL of iron(II) solution and absorbance data on the board. Copy the entire set of data from the board onto the Group Data Sheet (last page). If instructed, you should also enter the data into the computer; ask your Instructor for help.

Treatment of Data:

Review your hypothesis; remember you are looking for a relationship between the quantity of product obtained and the quantity of iron(II) solution added. Using the Group Data, plot the absorbance of the mixture on the y-axis versus the mL of iron(II) solution used on the x-axis. Describe the result of this plot.

Can you draw a straight line (or lines) through the points? Explain.

The absorbance of the solution is due only to the compound, $[\text{Fe}(o\text{-phen})_x]^{2+}$, as neither the $\text{Fe}^{2+}(\text{aq})$, the $\text{NH}_4^+(\text{aq})$, the $\text{SO}_4^{2-}(\text{aq})$, or the *o*-phen absorb light at 510 nm. Thus, from the plot above, you can determine when the reaction between the $\text{Fe}^{2+}(\text{aq})$ and *o*-phen is complete.

At the intersection of the two portions of the straight lines, carefully estimate the mL of iron(II) solution required for complete reaction with the 10 mL of *o*-phen.

_____ mL of $\text{Fe}^{2+}(\text{aq})$

Determine the moles of $\text{Fe}^{2+}(\text{aq})$ and *o*-phen(aq) at this point.

moles of $\text{Fe}^{2+}(\text{aq})$ _____

moles of *o*-phen _____

Write a balanced chemical equation based on the reaction from page 2.

Do the results confirm your hypothesis? Explain.

Group Data Sheet

	Trial #1		Trial #2	
Group Number	mL of FeS₀₄	Absorbance	mL of FeS₀₄	Absorbance
1	2		20	
2	4		18	
3	6		16	
4	8		14	
5	9		13	
6	10		12	
7	11		9	
8	12		10	
9	13		9	
10	14		8	
11	16		6	
12	18		4	
13	20		2	
14	10		12	
15	11		9	
16	12		10	
17	13		9	