IRON (III) NITRATE AND POTASSIUM THIOCYANATE
Exp. I-5

Name_____ Lab Section _____

Lab Partner_____

Pre-Lab Assignment: Review the textbook discussion of molar (mole/liter) concentration units. Study Appendix D.1 on buret volume measurements and Appendix D.2 on the theory and use of spectrophotometers.

Problem Statement: What controls the amount of reaction between Fe^{3+} and SCN^-?

I. Data Collection and Analysis: Qualitative

A. Dissolve about 1 cm^3 of hydrated iron (III) nitrate, $Fe(NO_3)_3(H_2O)_9$, in 20 mL of distilled water. Dissolve about 1 cm^3 of potassium thiocyanate, KSCN, in another 20 mL of water. Label each solution and describe the appearance of each.

B. Mix about 10 mL of each solution in a third beaker. Describe the results. (Set aside the remaining 10 mL of the $Fe(NO_3)_3$ and KSCN solutions for use in part III.C).

C. The observed reaction is: $Fe^{3+}(aq) + SCN^-(aq) \rightarrow FeSCN^{2+}(aq)$. Identify the color of each reactant and product ion.

II. Data Collection—Quantitative: $Fe^{3+}(aq) + SCN^{-}(aq) \rightarrow FeSCN^{2+}(aq)$

You will be using a spectrophotometer to measure the color intensity and thus the concentration of the $FeSCN^{2+}(aq)$ formed in several solutions. Since the experiments depend on concentrations, it is important for the precision of the results that the volume measurements be made with care. Review Appendix D.1 on the proper use of burets. Also, you should be careful not to unwittingly dilute or contaminate your solutions.

A. Label eight dry 150 mm test tubes as numbers 1 to 8. Obtain in separate, dry, labeled beakers 80 mL of KSCN solution and 80 mL of $Fe(NO_3)_3$ solution. Record the exact molar concentration of each solution in the table on page 179. (Each solution contains HNO_3 at 0.3 M to prevent the formation of iron hydroxides.)

Clean two burets. Rinse one with two 5 mL portions of the KSCN, and rinse the other with $Fe(NO_3)_3$ solution. Fill each buret with the appropriate solution, making sure the tip is free of air gaps. Rinse and fill a third buret with distilled water. Label each buret.

B. You are to prepare eight solutions of the two reactants such that each contains the same amount of KSCN but differing amounts of $Fe(NO_3)_3$ in 20.00 total mL. This will be done by carefully buretting amounts of the stock solutions into the test tubes. The amounts suggested are given in the following table.

Test Tube	mL Stock KSCN	mL Stock $Fe(NO_3)_3$	mL H_2O
1	5.00	0.50	14.50
2	5.00	1.00	14.00
3	5.00	1.50	13.50
4	5.00	2.00	13.00
5	5.00	2.50	12.50
6	5.00	10.00	5.00
7	5.00	13.00	2.00
8	5.00	15.00	0.00

Make up your solutions recording the exact volumes used (to ± 0.01 mL) in the table on page 179. The order of addition of the reagents is not important.

Mix each solution by stoppering with a rubber stopper and inverting the tube several times. Shaking will not properly mix the reagents. Be sure to wipe the stopper dry between use with different test tubes.

C. Read the color intensity (absorbance) of the $FeSCN^{2+}$ in each solution and record it in the table. In using the spectrophotometer follow the directions provided by the instructor and/or those given in Appendix D.2. The light wavelength of 447 nm is suggested for the measurements.

Retain at least 5 mL of test solution #2 for use in part III.C. If a spectrophotometer is not immediately available for your use, do parts III.A, B, and C while you are waiting.

Data Table

Molarity of stock KSCN solution _____M

Molarity of stock $Fe(NO_3)_3$ solution _____M

Test Tube	mL Stock KSCN	mL Stock $Fe(NO_3)_3$	mL H_2O	Total added SCN^- conc (M)	Total added Fe^{3+} conc (M)	Absorbance at 447 nm
1						
2						
3						
4						
5						
6						
7						
8						

III. Data Analysis

A. Calculate the total M concentration of SCN^- and Fe^{3+} added to each test solution. Enter these in the table on page 179. Show the calculations for test solution #5 below.

B. Considering that fact that Fe^{3+} and SCN^- react 1:1 to form the colored ion $FeSCN^{2+}$, what is the ***maximum*** mole/liter concentration of $FeSCN^{2+}$ that could form in each test solution? Explain your reasoning below. (Hint: What is the limiting reagent in each solution?)

C. Into each of 3 small test tubes put 10 drops (½ mL) of test solution #2. Into one put 5 drops of the KSCN solution you prepared in part I.A. Into the second test tube put 5 drops of the $Fe(NO_3)_3$ solution from part I.A; into the third put 5 drops of H_2O. Mix the solutions and compare them. Describe the results. What do the results indicate about the completeness of the reaction in test solution #2? Briefly explain your reasoning.

D. What conclusions can be drawn from the data on page 179 about the completeness of the reaction in each test solution? Offer an explanation for your findings. It may be helpful to graph the absorbance vs. Fe^{3+} data. (Hints: Since Absorbance = constant x $[FeSCN^{2+}]$, how would the absorbances compare if the reaction went to completion in each solution? How can the actual absorbances be explained? Why might the reaction apparently go to completion in some situations but not in others?)

IV. Mathematical Analysis

A. To analyze the data mathematically, we need to determine the constant in the equation:

$$\text{Abs} = \text{constant} \times [FeSCN^{2+}]$$

This can be done by inspecting the graph in part III.D. If this graph has a plateau, we can assume these solutions are about 100% reacted. Thus their $[FeSCN^{2+}]$ can be calculated.

Using this approach, determine a value for the constant in the equation above. Then use this value with the non-plateau solutions and compute $[FeSCN^{2+}]$, $[SCN^-]$, and $[Fe^{3+}]$. Enter the data in the following table. Show one of these calculations in the space below.

Test Tube	Actual Concentrations (M) of			Results: Possible Combinations		
	$FeSCN^{2+}$	SCN^-	Fe^{3+}			
1						
2						
3						
4						
5						
6						
7						
8						

B. What conclusions can be drawn from these data? Find an algebraic equation that relates the actual concentrations of $FeSCN^{2+}$, SCN^-, and Fe^{3+} to each other in the non-plateau solutions. (Hint: Try all possible combinations of the three concentrations by multiplication and/or division. For example, multiply all three together, multiply two and divide by the third, etc., looking for the combination that gives the most constant result.) Summarize your results in the table above. Be sure to label each column. Discuss your results below.