Procedure

Part A. Preparing the Solutions

1. Obtain ten 50-mL beakers or large test tubes.
2. Prepare the five reference solution in test tubes or beakers as listed in the table below. Use a separate pipet to transfer the appropriate volumes of each reagent. Mix each solution using a stirring rod. Rinse the stirring rod and dry it between solutions. Label the test tubes or beakers with the corresponding reference solution number.

Standard	Volume of 0.200 M $Fe(NO_3)_3$ Solution	Volume of 0.0002 M KSCN Solution
Reference solution 1	8.0 mL	2.0 mL
Reference solution 2	7.0 mL	3.0 mL
Reference solution 3	6.0 mL	4.0 mL
Reference solution 4	5.0 mL	5.0 mL
Reference solution 5	4.0 mL	6.0 mL

3. Using a separate pipet for each reagent to be added, combine the following volumes of reagents to prepare the test solutions. *Note:* Label the tubes with the corresponsing solution numbers 6 through 10. Read the reagent labels carefully before use!

Sample	Reagents		
	0.0020 M $Fe(NO_3)_3$	0.0020 M KSCN	Distilled Water
Test solution 6	5.0 mL	1.0 mL	4.0 mL
Test solution 7	5.0 mL	2.0 mL	3.0 mL
Test solution 8	5.0 mL	3.0 mL	2.0 mL
Test solution 9	5.0 mL	4.0 mL	1.0 mL
Test solution 10	5.0 mL	5.0 mL	0 mL

4. Mix each solution using a stirring rod. Rinse the stirring rod and dry it between solutions.
5. Measure the temperature of one of the solutions and record it in the above Test Solutions Data Table. This is assumed to be the equilibrium temperature for all of the solutions.

Part B. Colorimetry Measurements

1. Follow the procedure for your colorimetric measurements of the solution as directed by the instructor. Generally, spectrophotometers are used as follows: Turn the instrument on and allow it to warm up for 15 minutes. Set the wavelength at 450 nm. With no light passing through the instrument to the phototube, set the percent transmittance to zero with the "zero" control. Handle cuvets at the top so no fingerprints are in the light path. Polish cuvets with a tissue. Place a cuvet which is about 2/3 full of distilled water into the sample holder and set the percent transmittance to 100% with the appropriate control (not the zero control). Fill a cuvet about 2/3 full of a test solution, place it in the spectrophotometer and read the absorbance. Consult the instrument manual for details on its use.
2. Measure the absorbance of each of the reference solutions at 450 nm, using distilled water as the zero absorbance reference in the spectrophotometer. If absorbance is difficult to measure precisely on the meter because it is in the high range where the numbers are close together, measure percent transmittance and calculate the absorbance for each solution. Absorbance $= -\log T$, where T is transmittance expressed as a decimal. Record the absorbance value for each reference solution used in the Reference Solutions Data Table.
3. Repeat step 2 for each of the test solutions. Record the absorbances in the Test Solution Data Table.
4. Dispose of the contents of the cuvets and of the remaining test solutions as directed by your instructor. Follow your instructor's directions for rinsing and drying the cuvets.

Data Tables and Graph

Reference Solutions

Temperature: 22 c°

Sample	$[FeSCN^{2+}]$	Absorbance
Reference solution 1		0.357
Reference solution 2		0.399
Reference solution 3		0.381
Reference solution 4		0.409
Reference solution 5		2.042

Test Solutions

Temperature: 22 c°

Sample	$[Fe^{3+}]$*	$[SCN^-]$*	Absorbance
Test solution 6			0.687
Test solution 7			1.753
Test solution 8			1.927
Test solution 9			1.851
Test solution 10			1.720

*These are the concentrations of ions in solution immediately after mixing and before any reaction has occurred. See the *Pre-Laboratory Assignment* for calculations.

Results Table

Sample	$[FeSCN^{2+}]_{eq}$	$[Fe^{3+}]_{eq}$	$[SCN^-]_{eq}$	K_{eq}
Test Solution 6				
Test Solution 7				
Test Solution 8				
Test Solution 9				
Test Solution 10				

Average value: ____________

Average deviation: ____________

Absorbance versus Concentration Graph

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Post-Laboratory Review Questions

1. On the previous page, plot the molar concentration of $FeSCN^{2+}$ versus absorbance as shown in Figure 1, and draw the best-fitting straight line through the data points. Include the origin (zero absorbance for zero concentration) as a valid point.

Calibration Curve for Absorbance of $FeSCN^{2+}$

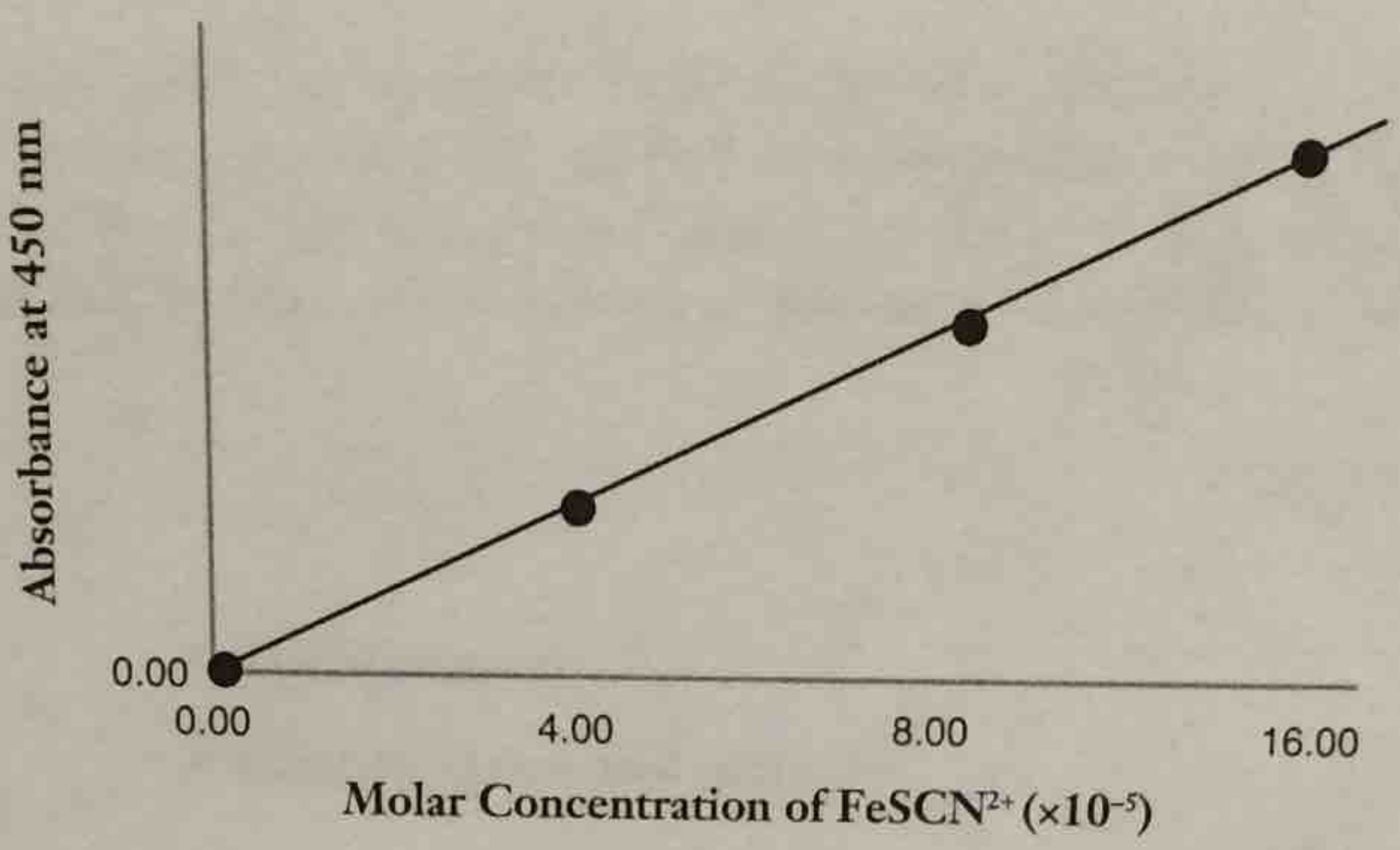

Figure 1.

2. The unknown concentration of $FeSCN^{2+}$ ions in each test solution can be determined from the graph. Find the absorbance value of the test solution, read across to the best-fit, straight-line curve, and then down to the x-axis to find the concentration.
3. Record the $FeSCN^{2+}$ concentration for each test solution in the Results Table.
4. Calculate the equilibrium concentration of Fe^{3+} ions in each test solution 6–10 by subtracting the equilibrium concentration of $FeSCN^{2+}$ ions from the initial concentration of Fe^{3+} ions (see the Test Solutions Data Table). Enter the results in the Results Table.

   $[Fe^{3+}]_{eq} = [Fe^{3+}]_{initial} - [FeSCN^{2+}]_{eq}$
5. Calculate the equilibrium concentration of SCN^- ions in each test solution 6–10 by subtracting the equilibrium concentration of $FeSCN^{2+}$ ions from the initial concentration of SCN^- ions (see the Test Solutions Data Table). Enter the results in the Results Table.

   $[SCN^-]_{eq} = [SCN^-]_{initial} - [FeSCN^{2+}]_{eq}$
6. Use Equation 4 in the *Background* section to calculate the value of the equilibrium constant K_{eq} for each test solution 6–10. Enter the results in the Results Table.
7. Calculate the *mean* (average value) of the equilibrium constant for the five test solutions and enter below the Results Table.
8. Calculate the *average deviation* for K_{eq} by finding the absolute value of the difference between each individual value of the equilibrium constant and the mean. The average of these differences for solutions 6–10 is equal to the average deviation. Record the average deviation below the Results Table.
9. The average deviation describes the precision of the results. Does the precision indicate that the equilibrium constant is indeed a "constant" for this reaction? Explain.
10. Describe the possible sources of error in this experiment and the likely effects on the results.