Chemistry 12 Lab 19B
Determination of an Equilibrium Constant

NAME ____________________

PARTNER ____________________

DATE ______________ BLOCK _____

In this lab you will mix varying concentrations of $Fe(NO_3)_{3(aq)}$ with $KSCN_{(aq)}$. The $NO_3^-{}_{(aq)}$ and $K^+{}_{(aq)}$ are not involved in any reaction in this lab so the equation you will be studying is summarized by:

$$Fe^{3+}{}_{(aq)} + SCN^-{}_{(aq)} \Leftrightarrow FeSCN^{2+}{}_{(aq)}$$

The $FeSCN^{2+}{}_{(aq)}$ ion gives a color from orange to blood-red depending on the concentration of the ion. Because the color changes with concentration, we can measure the concentration indirectly by using the Spectronic 20 spectrophotometer.

Pre-Lab Questions:

1. Write the K_{eq} expression for the above equilibrium equation.

   K_{eq} = ____________________

2. In a K_{eq} expression, from where do we get the exponent values for each of the [ ]?

   ____

3. The $FeSCN^{2+}{}_{(aq)}$ ion gives a fairly dark blood-red color for a certain initial $[Fe^{3+}]$. Given the equilibrium equation at the top of the page, what intensity of color would you expect if the initial $[Fe^{3+}]$ is reduced? Why?

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4. Solve for the equilibrium concentration of $FeSCN^{2+}{}_{(aq)}$ if the equilibrium concentrations of $Fe^{3+}{}_{(aq)}$ is 0.150 M and $SCN^-{}_{(aq)}$ is 0.250 M. The K_{eq} for this reaction = 260.

PART 1: Reaction of SCN^- with Various Dilutions of Fe^{3+}

Follow the instructions as given in PART 1 of this lab, except as noted below. "Next page" →

It's very important that your lab equipment is clean and dry for this lab. The dilution factors that you perform on page 216 are critical for accurate lab results. Take your time and be careful.

Use two different 10 mL graduated pipets when measuring the two chemicals in this section. Do not mix the two pipets with each other.

PART 2: Measuring the Concentration of $FeSCN^{2+}$ with a Spectrophotometer

Follow the instructions as given in PART 2 of this lab.

test tube	initial $[Fe^{3+}]$	initial $[SCN^-]$	absorbance
A	0.1000 M	0.00100 M	
B	0.0400 M	0.00100 M	
C	0.0160 M	0.00100 M	
D	0.0064 M	0.00100 M	
E	0.0026 M	0.00100 M	

Calculations

1. Refer to the dilution flowchart on page 216 and calculate the initial $[Fe^{3+}]$ and $[SCN^-]$. Write your answers in the data table above.

2. The calculations of the equilibrium $[Fe^{3+}]$, $[SCN^-]$, and $[FeSCN^{2+}]$ are based on the assumption that in test tube "A" there was so much excess Fe^{3+} (100× more than SCN^-) that all of the available SCN^- must have reacted to give the $FeSCN^{2+}$ colored ion. Since the initial $[SCN^-]$ is always equal to 0.00100 M, we will assume that the absorbance given in test tube "A" is equivilent to an equilibrium $[FeSCN^{2+}]$ = 0.00100 M. The equilibrium $[FeSCN^{2+}]$ in test tubes "B" through "E" is calculated by the following:

$$\text{equilibrium}\left[FeSCN^{2+}\right]_{\text{test tube } \chi} = (0.00100) \times \left(\frac{\text{Absorbance}_{\text{test tube } \chi}}{\text{Absorbance}_{\text{test tube "A"}}}\right)$$

For example, to calculate the equilibrium concentration of $FeSCN^{2+}$ in test tube "B", use the following equation. . . .

$$\text{equilibrium}\left[FeSCN^{2+}\right]_{\text{test tube B}} = (0.00100) \times \left(\frac{\text{Absorbance}_{\text{test tube B}}}{\text{Absorbance}_{\text{test tube A}}}\right)$$

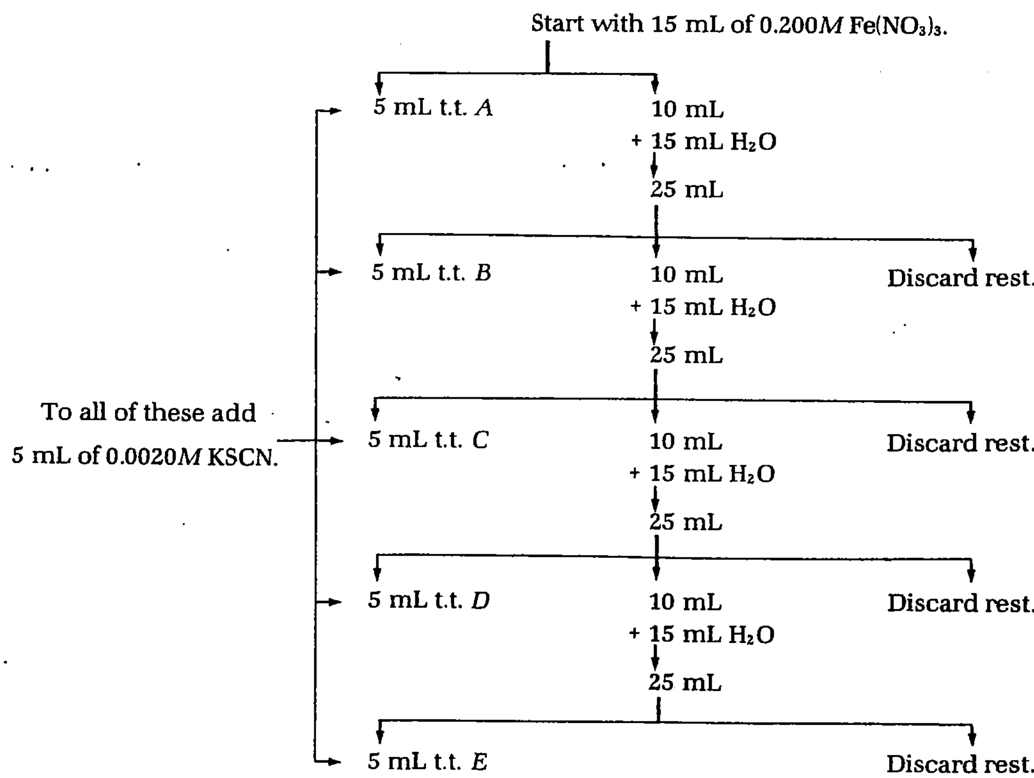
Calculate the equilibrium concentrations if $FeSCN^{2+}$ for test tubes B through E and enter these values in the following ICE boxes. . . .

PROCEDURE

Part I Reaction of SCN^- with Various Dilutions of Fe^{3+}

1. Put on your lab apron and safety goggles.
2. Obtain in separate beakers approximately 30 mL of 0.0020*M* KSCN and 20 mL of 0.200*M* $Fe(NO_3)_3$.
3. Place the five 18 mm × 150 mm test tubes in a rack and label them *A* to *E*. (Note: The test tubes should be clean and dry.)
4. Measure 5.0 mL of 0.200*M* $Fe(NO_3)_3$ in a 10 mL graduated cylinder and transfer it to test tube *A*.
5. Measure 10.0 mL of the $Fe(NO_3)_3$ solution into a 25 mL graduated cylinder. Add water to make it up to the 25 mL mark, then transfer it to a clean, dry beaker to mix.
6. Using your 10 mL graduated cylinder, transfer 5.0 mL of this diluted solution to test tube *B*. (If the cylinder is wet, rinse it with about 2 mL of your solution first.) Then measure 10 mL of the diluted solution, again in the 10 mL cylinder, and pour it into the 25 mL cylinder (it can be wet). Make up to 25 mL with water.
7. Repeat Step 6 with this new, diluted solution, but place the 5 mL portion in test tube *C*, and continue similar dilutions of 10 mL to 25 mL to get 5 mL portions in test tubes *D* and *E*.
8. To each test tube add 5.0 mL of 0.0020*M* KSCN.

The following flowchart may help to clarify the dilution procedures:



Insert the equilibrium concentrations for FeSCN2+ in each of the following ICE boxes and calculate the value of K_{eq} for each test tube.

Test Tube B

	Fe^{3+} +	SCN^- ⇔	$FeSCN^{2+}$
I	0.0400	0.00100	0
C	-x	-x	+x
E			

$$K_{eq} = \frac{[FeSCN^{2+}]}{[Fe^{3+}][SCN^-]} = \underline{\hspace{6cm}} = \underline{\hspace{2cm}}$$

Test Tube C

	Fe^{3+} +	SCN^- ⇔	$FeSCN^{2+}$
I	0.0160	0.00100	0
C	-x	-x	+x
E			

$$K_{eq} = \frac{[FeSCN^{2+}]}{[Fe^{3+}][SCN^-]} = \underline{\hspace{6cm}} = \underline{\hspace{2cm}}$$

Test Tube D

	Fe^{3+} +	SCN^- ⇔	$FeSCN^{2+}$
I	0.0064	0.00100	0
C	-x	-x	+x
E			

$$K_{eq} = \frac{[FeSCN^{2+}]}{[Fe^{3+}][SCN^-]} = \underline{\hspace{6cm}} = \underline{\hspace{2cm}}$$

Test Tube E

	Fe^{3+} +	SCN^- ⇔	$FeSCN^{2+}$
I	0.0026	0.00100	0
C	-x	-x	+x
E			

$$K_{eq} = \frac{[FeSCN^{2+}]}{[Fe^{3+}][SCN^-]} = \underline{\hspace{6cm}} = \underline{\hspace{2cm}}$$

1. List your values for K_{eq} from the smallest value to the largest value.

smallest = ____________________

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largest = ____________________

2. Of your four answers for the value of K_{eq}, list the average value. ____________________

3. Your four answers for the value of K_{eq} should have been the same - it is a constant you know. . . .
Explain any variations as best you can.

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