Pre-Laboratory Assignment Experiment 18
Equilibrium Constant Name_______________________________#______Score______

1. Write the equation and the equilibrium constant expression for the reaction under study in the experiment.

THE EQUATION IS
$fe^{+3} + SCN^{-1} \Leftrightarrow feSCN^{+2}$

2. What species is being spectrophotometrically measured?

3. What is the color of the species?

4. What is a standard curve?

5. Given the following data prepare a Plot of Absorbance vs [$FeSCN^{+2}$]

Absorbance	[$FeSCN^{+2}$] x10^{-4}
0.01	0.02
0.2	0.4
0.5	1.1
0.71	1.59

6. What is the [$FeSCN^{+2}$] at an absorbance of 0.35 from the standard curve ?

EXPERIMENT 18

EQUILIBRIUM CONSTANT-TRANSITION METAL COMPLEX-K_{eq}

OBJECTIVES

a) To determine the equilibrium constant for a reaction.
b) To pprepare a calibration curve and apply it.
c) To become familiar with the use of a spectrophotometer.
d) To understand the concept of absorbance and transmittance.

SUPPLIES AND EQUIPMENT

Spectronic 20, burets or pipets, 0.1M HNO_3, 2.00E-3M $Fe(NO_3)_3$ in 0.1M HNO_3, 2.00E-3M KSCN in 0.1M HNO_3, 0.2M $Fe(NO_3)_3$ in 0.1M HNO_3, Cuvets, Distilled Water, Kimwipes, Graph Paper, 100mL Volumetric Flasks

WHAT YOU SHOULD KNOW BEFORE YOU BEGIN

When light (white) is passed through a sample that is colored in solution, some of the light may be absorbed , while some of the light may be transmitted (pass through). The absorbed radiation is a result of the energy difference between two levels in the solute molecules. The molecule has become excited. The radiation that is not absorbed is thus transmitted and is detected by an instrument called a spectrophotometer. The relationship between the energy and the wavelength is : $E = hc / \lambda$ where h is Planck's Constant, c is the Speed of Light, and λ is the wavelength. A spectrophotometer is an instrument that is designed to measure the absorption of light at specific wavelengths. The absorption will occur at different wavelengths of light. The colored region of the electromagnetic spectrum which deals with this phenomenon is called the visible region. The values of the wavelength ranges from approximately 400nm (4000Å) to 700nm (7000Å) . The extent of absorption is proportional directly to the concentration of the absorbing species. The absorption maximum can be determined and utilized for numerous analyses. A diagram of a Spectrophotometer is shown below:

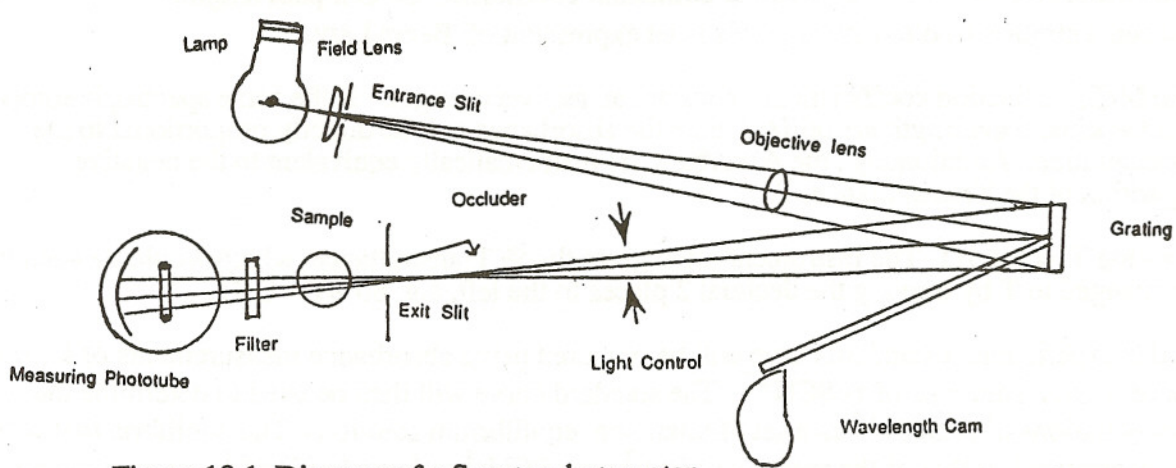

Figure 18.1 Diagram of a Spectrophotometer

The equation is: Fe^{+3} + SCN^{-1} <====> $FeSCN^{+2}$

$$\text{The equilibrium constant is : } K_{eq} = \frac{[FeSCN^{+2}]}{[Fe^{+3}][SCN^{-1}]}$$

The complex formed is a blood-red complex. Mixtures of the reactants will be prepared and the absorbance measured at a wavelength of 447nm. The reactions are carried out in 0.1M HNO_3 to prevent hydrolysis. A standard curve will be prepared of Absorbance vs [$FeSCN^{+2}$]. Unknown solutions will be prepared and the [$FeSCN^{+2}$] determined at reaction equilibrium from the standard curve. The [Fe^{+3}] initially is 2E-3M, and [SCN^{-1}] is 2E-3M. From the equilibrium concentration of $FeSCN^{+2}$ the amount of Fe^{+3} and the amount of SCN^{-1} at equilibrium will be determined, and the equilibrium constant calculated.

$$\text{The } [Fe^{+3}] \text{ at equilibrium} = \frac{\text{initial moles of } Fe^{+3} - \text{equilibrium moles of } FeSCN^{+2}}{\text{Volume Total in liters}}$$

$$\text{The } [SCN^{-1}] \text{ at equilibrium} = \frac{\text{initial moles of } SCN^{-1} - \text{equilibrium moles of } FeSCN^{+2}}{\text{Volume Total in liters}}$$

The equilibrium moles of $FeSCN^{+2}$ is determined by multiplying the Volume (liters) x [$FeSCN^{+2}$] at equilibrium.

The initial moles of reactants is determined by : V (liters) x Molarity (moles/liter)

EXPERIMENTAL PROCEDURE
(Designed for groups)
A. STANDARD CURVE

1. Obtain a clean buret, rinse it with distilled water and with 2.00E-3M KSCN (prepared in 0.1M HNO_3), and fill it with 2E-3M KSCN .

2. Obtain a second clean buret, rinse it with distilled water and with 2E-1M $Fe(NO_3)_3$ (prepared in 0.1M HNO_3), and fill it with 2E-1M $Fe(NO_3)_3$.

3. Place approximately 125mL of 0.1M HNO_3 in a 250mL beaker. Use for dilution to the calibration mark in each volumetric flask

4. Obtain six 100mL Volumetric flasks and label from #1-#6.
   Dispense from the buret the specified quantities as indicated in Table 18.2 below and dilute each to the 100mL calibration mark with 0.1M HNO_3.

Precautions: 1. The blank solution contains the solvent system utilized in the experiment.
2. Always rinse the cuvet with the next sample to be analyzed.
3. Always wipe the cuvet to remove all foreign substances including finger prints before insertion into the Spectrophotometer

Sample Keq Calculations

e.g. The absorbance of unknown 1 solution was found to be 0.3
Using the standard curve the [$FeSCN^{+2}$] was found equal to 0.7E-4M

Moles of $FeSCN^{+2}$ at equilibrium = Volume (total) x [$FeSCN^{+2}$] =
0.01liters x 0.7E-4M = 0.7E-6moles

Moles of Fe^{+3} initially = V x M = 4E-3liters x 2E-3M = 8E-6moles

Moles of SCN^{-1} initially = V X M = 5E-3liters x 2E-3M= 10E-6moles

Moles of Fe^{+3} complexed = Equilibrium moles of $FeSCN^{+2}$
0.7E-6moles

Moles of SCN^{-1} complexed = Equilibrium moles of $FeSCN^{+2}$
0.7E-6moles

Moles of Fe^{+3} at equilibrium = Initial - Equilibrium moles
8E-6 moles - 0.7E-6moles = 7.3E-6moles

Moles of SCN^{-1} at equilibrium = Initial - Equilibrium moles
10E-6 moles - 0.7E-6moles = 9.3E-6moles

[Fe^{+3}] at equilibrium = Moles at equilibrium / V total = 7.3E-6moles/ 0.01liters= 7.3E-4M

[SCN^{-1}] at equilibrium = Moles at equilibrium / V total = 9.3E-6moles/ 0.01liters= 9.3E-4M

[$FeSCN^{+2}$] = 0.7E-4M

$$\text{Equilibrium Constant} = K_{eq} = \frac{[FeSCN^{+2}]}{[Fe^{+3}][SCN^{-1}]}$$

Keq= 0.7E-4M/ 7.3E-4M x 9.3E-4M = 103 M^{-1}

Determinations:

$[FeSCN^{+2}]$ Standard Curve					
Moles-$FeSCN^{+2}$ at equilibrium					
Moles of Fe^{+3} = Moles of $FeSCN^{+2}$ complexed					
Moles of Fe^{+3} uncomplexed					
$[Fe^{+3}]$ at equilibrium					
Moles of SCN^{-1} = Moles $FeSCN^{+2}$ complexed					
Moles of SCN^{-1} uncomplexed					
$[SCN^{-1}]$ at equilibrium					
K_{eq}= Equilibrium Constant					

K_{eq} Average Equilibrium Constant ____________________

K_{eq} Standard Deviation ____________________

Show Determinations on lineless paper completely for any one set (column).

1. If the Absorbance of $FeSCN^{+2}$ was read higher than what it should be , what effect if any would this have on the value of Keq? explain