Chem 12 **UNIT 2**

Lab 2.1: $FeSCN^{+2}$ Equilibrium Constant

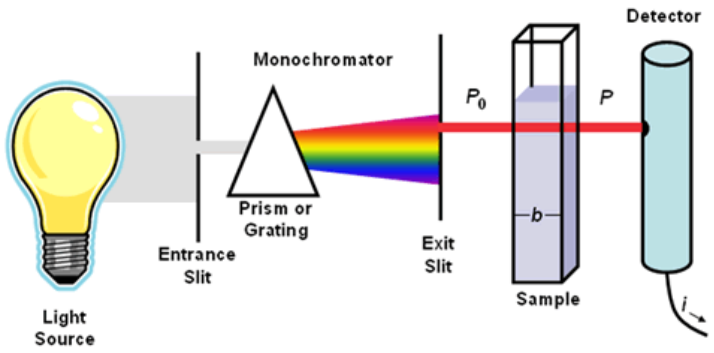
PURPOSE: to determine the equilibrium constant experimentally for the following reaction at equilibrium:

Fe^{+3} (aq) + SCN^{-} (aq) $\leftrightarrow$ $FeSCN^{+2}$ (aq)
(colourless) ***(dark brown)***

MATERIALS: *include* Absorption spectrophotometer, cuvettes (cells)

SPECTROPHOTOMETRY THEORY

Simplified drawing of a spectrophotometer:
(include this diagram, or your own version, in your Materials section)



Determination of an Absorption Spectrum:

When light passes through a solution, some of it is absorbed and some of it is transmitted.

What causes the light to be absorbed at all?
The photons of light are absorbed by the molecules of the solute and to some extent the solvent. (Usually, a ***blank*** (containing only solvent) is run through the spectrophotometer alone. This "corrects" for any absorbancy due to the solvent itself, therefore, absorbancy of your samples becomes that due to the solute.)

The light of visible wavelength (~340 nm to 700 nm) is not of very great energy. However, it is sufficient often times to cause an unpaired ***d*** electron in a given shell to move to a higher ***d*** level orbital in the same shell.

In other words, certain wavelengths of light are absorbed. This often occurs in the transition elements which have incompletely filled inner ***d*** orbitals and these ***d*** orbitals are not all of exactly the same energy (although very close). This is why compounds containing transition metals often times exhibit colour. Light of different wavelengths will be absorbed to different extents. No two substances have the same absorption spectrum. Therefore absorption spectra can be used to help identify a substance.

PROCEDURE:

Five reactions will be carried out in which the $[Fe^{+3}]$ will be varied through a cascade dilution procedure, while keeping the $[SCN^-]$ constant at 1.0×10^{-3} M. **(see schematic diagram).**
Tube #1 is the standard to which the spectrophotometer will be calibrated for all of your subsequent dilutions.
Each of the five reactions will be analyzed for $[FeSCN^{+2}]$ using a spectrophotometer.
The $[Fe^{+3}]e$, $[SCN^-]e$, and $[FeSCN^{+2}]e$ will be calculated. **(see table 1).**
Mathematical calculations of concentrations will be performed using the results obtained from the 5 reactions, to determine the equilibrium constant for the reaction.

DATA

Table 1 - include units wherever possible. It is not necessary (or possible?) to include uncertainties for this lab, unless you are labeling your schematic dilution of the cascade dilutions.

CALCULATIONS:

1. Show all calculations necessary for columns A and B in Table 1. (see space provided **on Table 1**).
2. For columns D, E, and F, show calculations ***on a separate page***, as "I.R.E." analysis for EACH OF THE FIVE TUBES, including your calculation for the K_{eq} value for each tube.
3. Calculate the average K_{eq} value for your experiment.

QUESTIONS: Use Reaction Kinetics Terminology, and Equilibrium concepts in your responses.

1. Clearly explain, (or even justify), the use of the sample in tube # 1 as the standard to which the spectrophotometer was calibrated for all of the subsequent dilution samples.
2. What does the value of K_{eq} represent, exactly, in terms of reactants and products?
Be clear, descriptive, and thorough in your response.
3. Based on your I.R.E. or **ICE** calculations, which way does the reaction proceed INITIALLY?
What does this mean to say the reaction proceeds in the forward or reverse direction initially?
4. Based on your I.R.E. or **ICE** calculations, which way does the reaction proceed AT EQUILIBRIUM?
(i.e. Is the forward or reverse reaction favoured at equilibrium?) ***WHY?***
What does this mean to say the reaction favours the forward or reverse direction at equilibrium?
Be clear, descriptive, and thorough in your response.

DISCUSSION: Carefully read the Lab Report Format handout to complete these three sections correctly

- ***Sources of Error***

Suggest possible reasons for any discrepancies between your calculated K_{eq} values, in terms of procedural or instrumental inadequacies. Carefully read the Lab Report Format handout to correctly complete this section.

- ***Analysis of accepted values***

Be sure to communicate mathematically how close together your experimental K_{eq} values are. Include a statement analyzing what you have calculated here. This may relate directly to your sources of error.

- ***Relevant Theory***

Carefully read the Lab Report Format handout to correctly complete this *presentation and interconnection of theories and concepts* section. Your primary focus should be on equilibrium concepts. You can choose whether you want to discuss the theory of spectrophotometry as part of this section.

CONCLUSION:

Complete this section, as directed on the Lab Report Format Handout for Chemistry lab reports.