

Experiment 5 lab: Colorimetric determination of equilibrium constant in an aqueous solution

Amoy. Stephenson

Due Date; March 17th

Lund.k

Page 1

Purpose: by calculating the light absorbed in the experiment which is equivalent to concentration we can find the equilibrium constant.

Procedure:

Part A: label 6 volumetric flasks and add 10 ml of 0.2M Ferric Nitrate into each flask. Next pipet 1.0 ml - 5.0ml of 2.0 mM sodium thiocyanate into each flask respectively using flask one as a blank and then dilute each flask with 0.10M Nitric Acid and mix well. Then rinse a cuvette and use flask one as blank to get a wavelength of 447nm. Rinse the cuvette again and use flask 2-6 and get the following wavelengths absorbances rinsing the cuvette in between each flask with water.

Part B: label 6 test tubes and add 5.0mL of 2.0mM ferric nitrate into each test tube. Next pipet 1.0 - 5.0 mL of 2.0 mM sodium thiocyanate solution into each test tube respectively after adding sodium thiocyanate add in 5.0 - 1.0mL of 0.1M nitric acid to test tubes 1–5 respectively and mix well. Measure the absorbance the same way in part A.

References: Lund. k, Experiment 5 lab: Colorimetric determination of equilibrium constant in an aqueous solution CHEM 1007 lab Manual, Nipissing University.

Materials:

Table 1: Part A solutions

<u>Solutions</u>	<u>Volume</u>
0.2M ferric nitrate	10 ml
0.002M sodium thiocyanate	5 ml
0.10 Nitric acid	1.0-5.0 ml

Table 2: Concentration of FeSCN with different levels of Nitric acid, with absorption of light at 447nm

<u>Test tube #</u>	<u>Concentration</u>	<u>wavelength</u>
Test tube #1 ( 1.0 ml of 0.10 Nitric acid)	0.00004M	0.04
Test tube #2 ( 2.0 ml of 0.10 Nitric acid)	0.00008M	0.11
Test tube #3 ( 3.0 ml of 0.10 Nitric acid)	0.00012M	0.22
Test tube #4 ( 4.0 ml of 0.10 Nitric acid)	0.00016M	0.26
Test tube #5 ( 5.0 ml of 0.10 Nitric acid)	0.0002M	0.32

Table 3. Part B solutions

Solutions	Volume
0.002M Ferric Nitrate	5.0ml
0.002M Sodium Thiocyanate	5.0ml
0.1M Nitric Acid	1.0-5.0 ml

Table 4: Concentration of FeSCN in part B with different levels of Nitric acid, with absorption of light at 447nm

<u>Test tube #</u>	<u>Concentration</u>	<u>wavelength</u>
Test tube #1 ( 1.0 ml of 0.10 Nitric acid)	0.0002M	0.05
Test tube #2 ( 2.0 ml of 0.10 Nitric acid)	0.0004M	0.14
Test tube #3 ( 3.0 ml of 0.10 Nitric acid)	0.0006M	0.19
Test tube #4 ( 4.0 ml of 0.10 Nitric acid)	0.0008M	0.25
Test tube #5 ( 5.0 ml of 0.10 Nitric acid)	0.001M	0.39

Table 5: other materials used

<u>Materials used in experiment</u>
Spectrophotometer
Volumetric flasks
Pipet
Cuvette
Test tubes

## Results

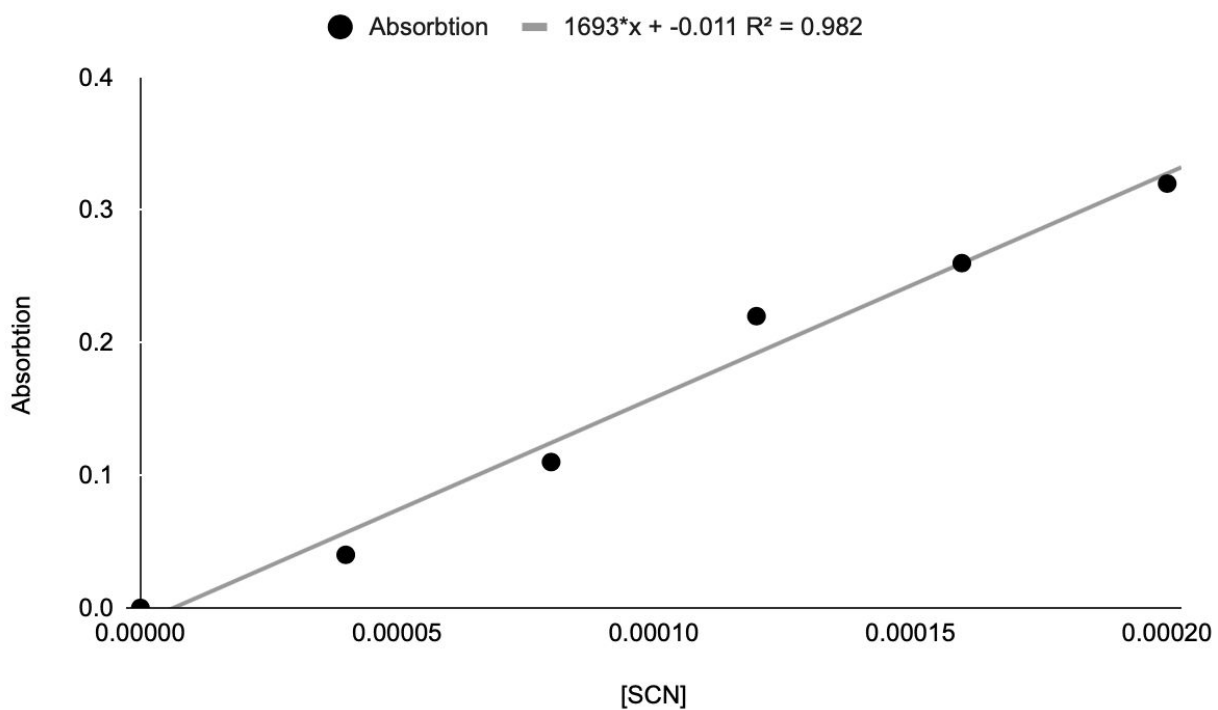


Figure1. Graph of the [FeSCN] with a y-axis equaling absorption.

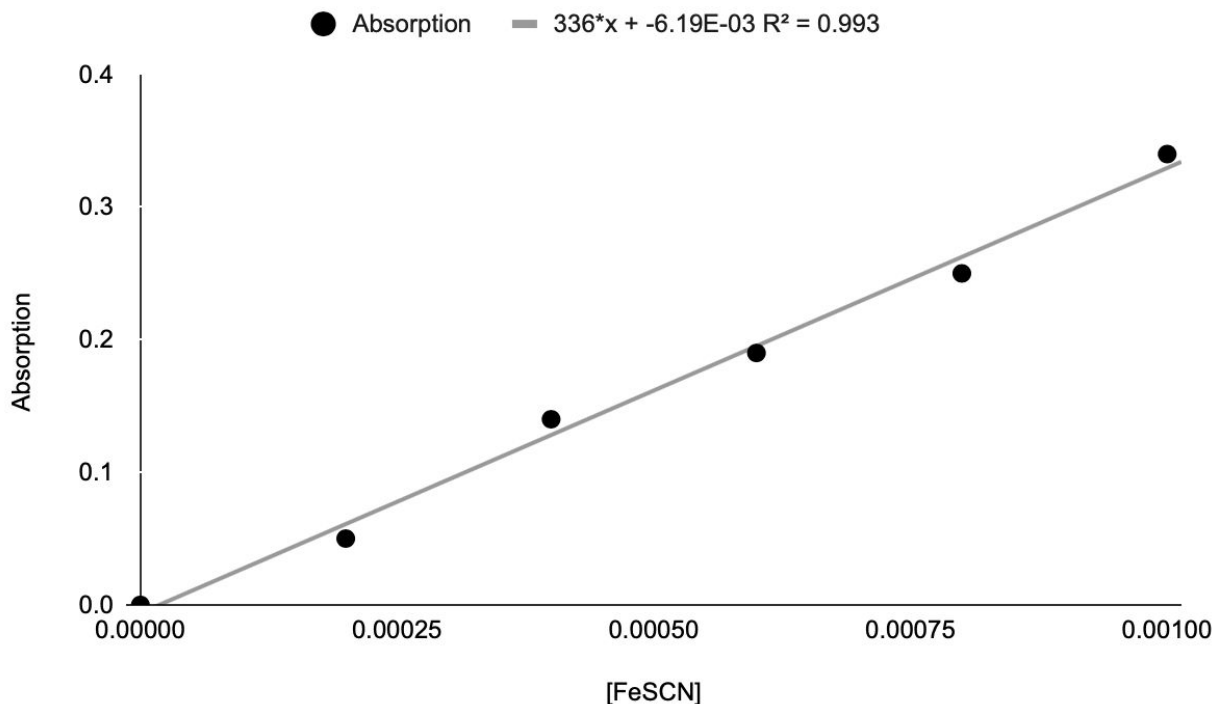


Figure 2. Graph of part b

Table 6: Part B finding X for [FeSCN] and the Keq for each solution, since test tube 1 was a blank I'm not including it in this table.

<u>Test tube #</u>	<u>Value of X</u>	<u>Keq</u>
Test tube # 2	$3.6 * 10^{-5}$	548780
Test tube # 3	$8.92 * 10^{-5}$	-44600
Test tube # 4	$1.19 * 10^{-4}$	247917
Test tube # 5	$1.54 * 10^{-4}$	5500
Test tube # 6	$2.37 * 10^{-4}$	47400
Average		133342.17

Page 5.

### Calculations

For part A Table 2:  $C_1V_1=C_2V_2$  was used to find the [SCN]

example :

$$0.002M * 1.0ml = C_2 * 50.0ml$$

$$0.002M * 1.0ml / 50.0ml = C_2$$

$$0.00004 = C_2$$

For part B Table 4:

$C_1V_1=C_2V_2$  was used to find the [Fe] example :

$$0.002M * 1.0ml = C_2 * 10.0ml$$

$$0.002M * 1.0ml / 10.0ml = C_2$$

$$0.00002 = C_2$$

For part B Table 6 to find x of [FeSCN]  $y=mx+b$  was used and to find  $K_{eq}$  an ice table was used example:

$y=mx+b$  ( y is the absorbance from observation, m + b are both found on figure 1)

$$0.05 = 1693x + (-0.011)$$

$$0.05 - (-0.011) = 1693x$$

$$x = 3.6 \times 10^{-5}$$

Ice table example

	Fe	+	SCN	$\rightleftharpoons$	FeSCN
I	0.00004		0.0002		0
C	$-3.6 \times 10^{-5}$		$-3.6 \times 10^{-5}$		$+3.6 \times 10^{-5}$
E	$4 \times 10^{-6}$		$1.64 \times 10^{-4}$		$3.6 \times 10^{-5}$

$$K_{eq} = [3.6 \times 10^{-5}] / [4 \times 10^{-6}] \times [1.64 \times 10^{-4}]$$

$$K_{eq} = 548780$$

Questions :

1. The calibration curve created is only reliable if you're doing the experiment in M, i converted mM to M so if you try to compare the two graphs you will get a different line of best fit, equation line, and R2 value. Also the information gathered was based on the observation that was conducted in a controlled area so only if the experiment is repeated in a similar fashion can this graph be reliable.

2. In order to find  $K_{eq}$  I used the ICE table as the concentrations of Fe, SCN, and FeSCN to calculate the  $K_{eq}$  values. The average  $K_{eq}$  value is very large which means that the reaction is product favoured, the difference in  $K_{eq}$  among the solutions is due to the difference in calculation caused by calculation error; in theory the  $K_{eq}$  is supposed to start off small and gradually get bigger until the reaction eventually reached equilibrium and strats to go back down again but in this case the calculations are off meaning that the  $K_{eq}$  for the solutions are invaild. The difference between the concentration between the solutions in part A and B are due to the total volume used in part A and part B of the lab. Part A uses 50.0ml for a total volume and for part B it uses only 10.0ml for the total volume so the concentrations will vary between the two concentrations even when the Molarity of the concentration of the solutions are the same.

3. The  $K_{eq}$  of  $H_2O(g) + Cl_2O(g) \rightleftharpoons 2HOCl(g)$  :

$$K_{eq} = \frac{[1.54 \times 10^{-2}M]^2}{[8.50 \times 10^{-1}M] \times [3.10 \times 10^{-3}M]}$$

$$K_{eq} = 5.833$$

Therefore the  $K_{eq}$  of  $H_2O(g) + Cl_2O(g) \rightleftharpoons 2HOCl(g)$  is 5.833

4. For the following reaction  $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$  the concentration for  $N_2$  is 51.67 g and for  $3H_2$  the concentration is 8.92g. This was calculated through the  $c_1v_1=c_2v_2$  method for example:

$$0.055L (N_2 \text{ in } L) \times 1 = C_2 \times 1.0645 (\text{total volume})$$

$$C_2 = 5.17 \times 10^{-2} \times 1000$$

$$C_2 = 51.67g$$

5. The  $K_{eq}$  for containing 0.125 mol of HOCl, 0.100 mol of  $Cl_2O$  and 0.860 mol of  $H_2O$  is only 0.182 which is less than the  $K_{eq}$  that was calculated for this equation which means that the equilibrium will shift to the right. To find the  $K_{eq}$   $\frac{[HOCL]^2}{[H_2O][Cl_2O]}$ .