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## Part A. Determination of an Unknown Concentration

Q1. Record the concentration of your red solution: red solution = 12.0 ppm

Q2. *(1 pt)* Record the absorbance (measured at 480 nm) of your six standard solutions:

| Standard | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| % Red | 100% | 80% | 60% | 40% | 20% | 0 |
| % Blue | 0 | 20% | 40% | 60% | 80% | 100% |
| Absorbance | 0.224 | 0.179 | 0.135 | 0.089 | 0.045 | 0.0 |

Q3. Record the absorbance of the two unknown solutions:

Absorbance of Unknown #1 = 0.0 Absorbance of Unknown #2 = 0.241

Q4. *(1 pt)* Use Excel, Google sheets or a similar program to create a graph of Absorbance vs. Concentration of Red Solution for your six *standard* solutions, where your graph must include a linear trendline as well a title and labeled axes. Add a blank page to the end of this lab report, then paste your graph onto that page, and record the equation of your trend line below in standard y = mx + b format:

Equation: $Y = 0.0187x$

Q5. *(2 pt)* Calculate the % composition of red solution in each of your two unknown solutions then use the original concentration of red solution, *recorded in Q1*, to determine the parts-per-million concentration. Show an example of your work below:

| Solution | Unknown 1 | Unknown 2 |
|---|---|---|
| Percentage Red (%) | 0.0 | 107% |
| Concentration Red (ppm) | 0.0 | 12.9 |

$Y = 0.0187(x)$ Y = absorbance, x = concentration (ppm)

$\therefore 0.0 = 0.0187x \rightarrow x = 0.0$ ppm

$0.241 = 0.0187(x) \rightarrow x = \frac{0.241}{0.0187} = 12.888$ ppm

$\frac{12.9 \text{ ppm}}{12.0 \text{ ppm}} \times 100\% = 107\%$

## Part B. Determination of an Equilibrium Constant

**The following questions refer to the reaction shown below, where, unfortunately you will not have the opportunity to conduct this portion of the experiment this summer:**

$$Fe^{3+}(aq) + SCN^{-}(aq) \rightleftarrows Fe(SCN)^{2+}(aq)$$

*(yellow)* *(colorless)* *(red)*

Q6. *(2 pt)* Five non-equilibrium standard solutions of the reaction shown above are prepared as described on the following table. Calculate the concentration of $SCN^-$ in each standard once all reagents have been mixed together into a total volume of 25 mL; show at least one sample calculation in the space below:

| Standard | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Volume of 0.00150 M $Fe(NO_3)_3$ | 5.0 mL | 5.0 mL | 5.0 mL | 5.0 mL | 5.0 mL |
| Volume of 0.00150 M KSCN | 5.0 mL | 4.0 mL | 3.0 mL | 2.0 mL | 1.0 mL |
| Volume of 0.050 M $HNO_3$* | 15 mL | 16 mL | 17 mL | 18 mL | 19 mL |
| Concentration of $SCN^-$ in 25 mL | $3.0\times10^{-4}$ M | $2.4\times10^{-4}$ M | $1.8\times10^{-4}$ M | $1.2\times10^{-4}$ M | $6.0\times10^{-5}$ M |

~~$M_{KSCN} = M_{SCN^-} = 0.00150M$~~

* *Nitric acid is used to prevent the hydrolysis of iron (III)*

$n_{KSCN} = n_{SCN^-} = 0.00150M \times 0.005L = 7.5\times10^{-6}$ mol

$M_{SCN^-} = \frac{7.5\times10^{-6} \text{ mol}}{0.025L} = \boxed{3.0\times10^{-4}}$

$n_{Fe^{+}} = 0.0150M \cdot 0.005L = n_{SCN^-}$

Q7. If the final concentration of $Fe(SCN)^{2+}$ is equal to the initial concentration of $SCN^-$ calculated in Q6, complete the following table:

| Standard | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| $[Fe(SCN)^{2+}]$ | $3.0\times10^{-4}$ M | $2.4\times10^{-4}$ M | $1.8\times10^{-4}$ M | $1.2\times10^{-4}$ M | $6.0\times10^{-5}$ M |
| Absorbance @ 460 nm | 0.449 | 0.364 | 0.279 | 0.189 | 0.097 |

Q8. *(1 pt)* Create a curve of Absorbance vs. Concentration of $Fe(SCN)^{2+}$ for your five standard solutions, where your graph must include a linear trendline, a proper title and labeled axes; paste this graph onto the page you added to the end of this lab report beneath your graph from Part A (created in Q4). Record the equation of your trend line in y = mx + b format:

Equation: $y = 1465x + 0.0119$

Q9. *(2 pt)* Two equilibrium mixtures of the iron / thiosulfate reaction are prepared, where $HNO_3$ was added to bring the volume of each mixture to a total of 10.0 mL. Calculate the concentrations of $Fe^{3+}(aq)$ and $SCN^-(aq)$ in the 10-mL mixtures, showing at least one sample calculation of $[Fe^{3+}]_0$ and $[SCN^-]_0$ in the space below:

| Mixture | A | B |
|---|---|---|
| Volume of 0.00150 M $Fe(NO_3)_3$ | 5.0 mL | 5.0 mL |
| Volume of 0.00150 M KSCN | 2.0 mL | 3.0 mL |
| Concentration of $Fe^{3+}$ in 10 mL, $[Fe^{3+}]_0$ | $7.5\times10^{-4}$ M | $7.5\times10^{-4}$ M |
| Concentration of $SCN^-$ in 10 mL, $[SCN^-]_0$ | $3.0\times10^{-4}$ M | $4.5\times10^{-4}$ M |

$n_{Fe^{+3}} = n_{Fe(NO_3)_3} = 0.0015\ M \cdot 0.005\ L = 7.5\times10^{-6}\ mol \rightarrow M_{Fe^{3+}} = \frac{7.5\times10^{-6}}{0.010\ L} = \boxed{7.5\times10^{-4}\ M}$

$n_{SCN^-} = n_{KSCN} = 0.00150\ M \cdot 0.002\ L = 3.0\times10^{-6}\ mol \rightarrow M_{SCN^-} = \frac{3.0\times10^{-6}\ mol}{0.010\ L} = \boxed{3.0\times10^{-4}\ M}$

Q10. *(1 pt)* Use your standard curve to calculate the equilibrium concentration of $Fe(SCN)^{2+}$ in both of your mixtures; show at least one sample calculation in the space below:

| Mixture | A | B |
|---|---|---|
| Absorbance @ 460 nm | 0.218 | 0.301 |
| $[Fe(SCN)^{2+}]_{eq}$ | $1.4\times10^{-4}$ M | $2.0\times10^{-4}$ M |

$y = 1465x + 0.0119$ $\left.\begin{matrix} y = \text{absorb} \\ x = \text{concentration} \end{matrix}\right\}$ $0.218 = 1465x + 0.0119 \rightarrow x = \frac{0.218 - 0.0119}{1465}$

Q11. *(3 pt)* Set up ICE tables for Mixtures A and B, then determine the value of K for each mixture, as well as your average K value:

A)

| | $Fe^{3+}$ | $SCN^-$ | $Fe(SCN)^{2+}$ |
|---|---|---|---|
| i | $8.9\times10^{-4}$ | $4.4\times10^{-4}$ | 0 |
| c | $-x$ | $-x$ | $x$ |
| e | $7.5\times10^{-4}$ | $3\times10^{-4}$ | $1.4\times10^{-4}$ |

$x = 1.4\times10^{-4}$

$$K_A = \frac{1.4\times10^{-4}}{(7.5\times10^{-4})(3\times10^{-4})} = 6.2\times10^2$$

B)

| | $Fe^{3+}$ | $SCN^-$ | $Fe(SCN)^{2+}$ |
|---|---|---|---|
| i | $9.5\times10^{-4}$ | $6.5\times10^{-4}$ | 0 |
| c | $-x$ | $-x$ | $x$ |
| e | $7.5\times10^{-4}$ | $4.5\times10^{-4}$ | $2.0\times10^{-4}$ |

$x = 2.0\times10^{-4}$

$$K_B = \frac{2.0\times10^{-4}}{(7.5\times10^{-4})(4.5\times10^{-4})} = 5.9\times10^2$$

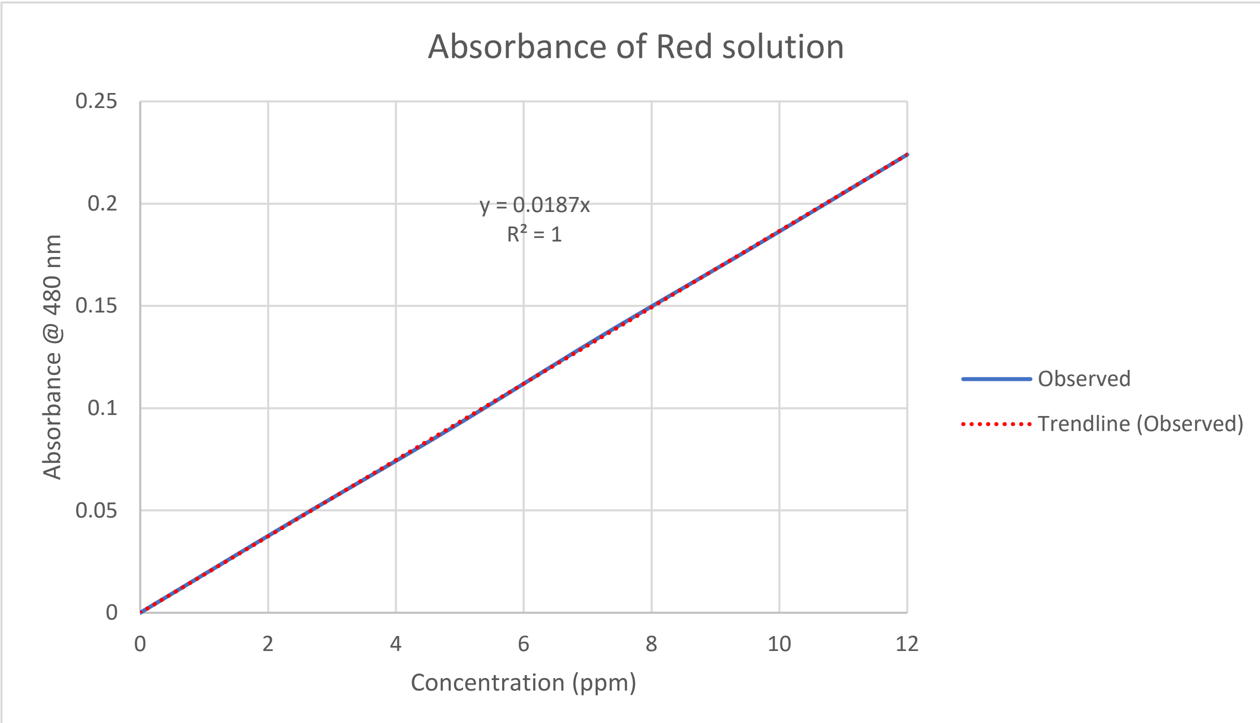
$$\boxed{K_{avg} = 6.1\times10^2}$$

Q12. *(1 pt)* If your classmate prepares an iron / thiosulfate mixture using different initial concentrations than you, would their K value be significantly different than yours? Explain.

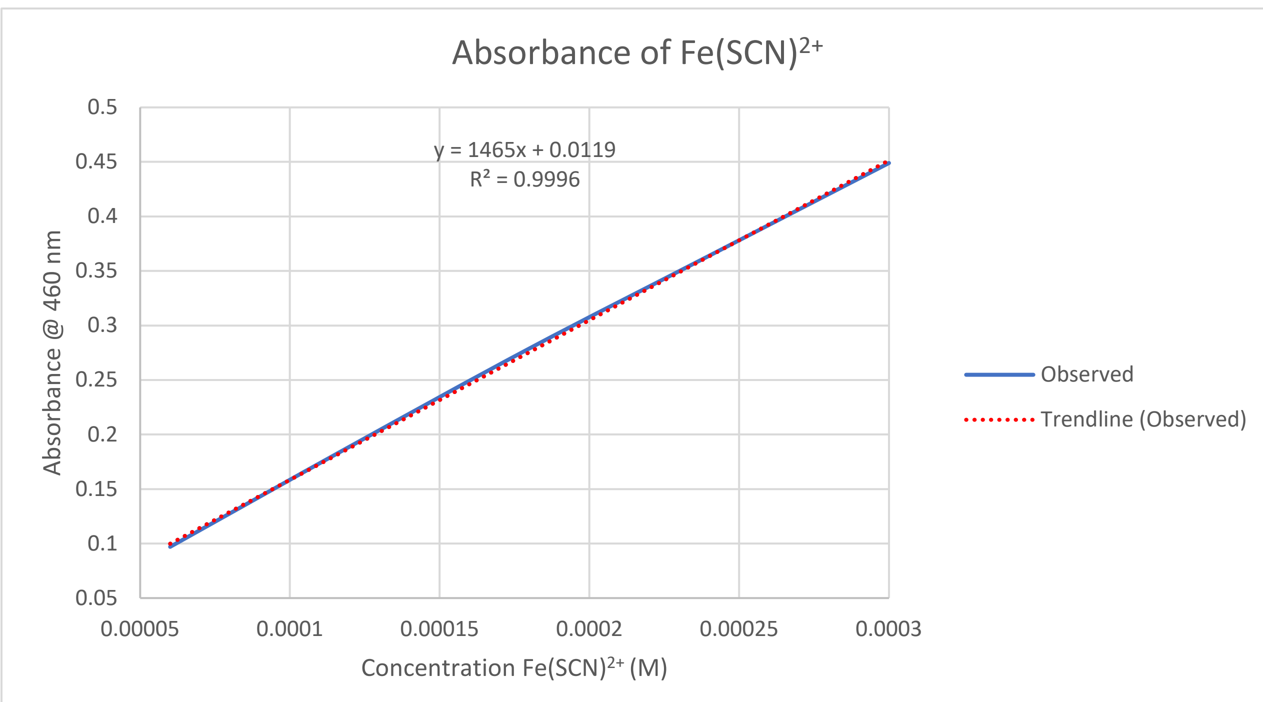
No because K is a ratio of Products & reactants @ equilibrium. No matter how much you start with, that ratio should be similar ~~because the~~

Q13. *(1 pt)* If your classmate prepares an iron / thiosulfate mixture using the same initial concentrations as you but runs their reaction at a different temperature, could their K value be significantly different than yours? Explain.

Yes – At a higher temperature, an exothermic reaction would favor the forward reaction and K would be greater.



Absorbance of Red solution
y = 0.0187x
R² = 1
Absorbance @ 480 nm
0.25
0.2
0.15
0.1
0.05
0
0
2
4
6
8
10
12
Concentration (ppm)
Observed
Trendline (Observed)

Absorbance of Fe(SCN)2+
y = 1465x + 0.0119
R² = 0.9996
Absorbance @ 460 nm
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0.00005
0.0001
0.00015
0.0002
0.00025
0.0003
Concentration Fe(SCN)2+ (M)
Observed
Trendline (Observed)