Clarified Directions for The Equilibrium Constant

Calculations:

Do the following calculations for each determination and record the results on the appropriate datasheet. (For how to do the calculations, refer to the example of $Cu(NO_3)_2$.)

1. Calculate the molarity of the original diluted $Fe(NO_3)_3$ solution.
2. Calculate the following for each of the 10 equilibrium solutions.
    a. Convert %T to A.

    $$A = \log(100 / \%T)$$

    b. Calculate [Fe*] and [SCN*].

    [Fe*] = initial # moles of Fe / V_{total}

    {**Note**: *while the initial # of moles of Fe does not change from one equilibrium solution to the next, the total volume does change.*}

    [SCN*] = # moles of SCN / V_{total}

    {**Note**: *Both the # of moles of SCN and the total volume will change from one equilibrium solution to the next.*}

    c. Calculate [Fe*] + [SCN*].
    d. Calculate [Fe*] [SCN*].
    e. Calculate A ([Fe*] + [SCN*]).

    {**Note:** *A is the Absorbance value for each equilibrium solution.*}

    d. Calculate A / ([Fe*] [SCN*]).
    f. Calculate A ([Fe*] + [SCN*]) / ([Fe*] [SCN*]).
3. Create a Beer's Law Plot, using

    x = A ([Fe*] + [SCN*]) / ([Fe*] [SCN*]).

    y = A / [Fe*] [SCN*]
4. Add a trendline to the plot. Determine the slope of the line to 3 significant digits.
5. Determine the equilibrium constant, K_{eq}, for the reaction.
6. Determine the concentration of the unknown.
    a. Make a Beer's Law plot with [Fe*] concentration on the x-axis & corresponding Absorbances on the y-axis.
    b. Add a trendline with equation.
    c. Plug in the absorbance for your unknown into the equation for "y" and solve for your concentration "x".

(Notes From Shruti for Monday Sections & Anyone who added 1ml of KSCN at a time:)
1st Row:

$[Fe^*] \Rightarrow C_1V_1 = C_2V_2$
$0.0025*10 = C_2*101$
Therefore, $C_2 = (0.0025*10)/101$
$C_2 = 2.475 \times 10^{-4}$

$[SCN^*] \Rightarrow C_1V_1 = C_2V_2$
$0.0025*1 = C_2*101$
Therefore, $C_2 = (0.0025*1)/101$
$C_2 = 2.475 \times 10^{-5}$

2nd Row:

$[Fe^*] \Rightarrow C_1V_1 = C_2V_2$
$0.0025*10 = C_2*102$
Therefore, $C_2 = (0.0025*10)/102$
$C_2 = 2.451 \times 10^{-4}$

$[SCN^*] \Rightarrow C_1V_1 = C_2V_2$
$0.0025*2 = C_2*102$
Therefore, $C_2 = (0.0025*2)/102$
$C_2 = 4.902 \times 10^{-5}$

3rd Row:

$[Fe^*] \Rightarrow C_1V_1 = C_2V_2$
$0.0025*10 = C2*103$
Therefore, $C_2 = (0.0025*10)/103$
$C_2 = 2.427 \times 10^{-4}$

$[SCN^*] \Rightarrow C_1V_1 = C_2V_2$
$0.0025*3 = C2*103$
Therefore, $C_2 = (0.0025*3)/103$
$C_2 = 7.282 \times 10^{-5}$

Etc.

(Notes for Anyone who added 2ml of KSCN at a time:)
1st Row:

$[Fe^*] \Rightarrow C_1V_1 = C_2V_2$
$0.0025*10 = C_2*102$
Therefore, $C_2 = (0.0025*10)/102$
$C_2 = 2.451 \times 10^{-4}$

$[SCN^*] \Rightarrow C_1V_1 = C_2V_2$
$0.0025*2 = C_2*102$
Therefore, $C_2 = (0.0025*2)/102$
$C_2 = 4.902 \times 10^{-5}$

2nd Row:

$[Fe^*] \Rightarrow C_1V_1 = C_2V_2$
$0.0025*10 = C_2*104$
Therefore, $C_2 = (0.0025*10)/104$
$C_2 = 2.404 \times 10^{-4}$

$[SCN^*] \Rightarrow C_1V_1 = C_2V_2$
$0.0025*4 = C_2*104$
Therefore, $C_2 = (0.0025*4)/104$
$C_2 = 9.615 \times 10^{-5}$

3rd Row:

$[Fe^*] \Rightarrow C_1V_1 = C_2V_2$
$0.0025*10 = C2*106$
Therefore, $C_2 = (0.0025*10)/106$
$C_2 = 2.358 \times 10^{-4}$

$[SCN^*] \Rightarrow C_1V_1 = C_2V_2$
$0.0025*6 = C2*106$
Therefore, $C_2 = (0.0025*6)/106$
$C_2 = 1.415 \times 10^{-5}$

Etc.

(Notes for Anyone who added 5ml of KSCN at a time:)
1st Row:

$[Fe^*] \Rightarrow C_1V_1 = C_2V_2$
$0.0025*10 = C_2*105$
Therefore, $C_2 = (0.0025*10)/105$
$C_2 = 2.381 \times 10^{-4}$

$[SCN^*] \Rightarrow C_1V_1 = C_2V_2$
$0.0025*5 = C_2*105$
Therefore, $C_2 = (0.0025*5)/105$
$C_2 = 1.190 \times 10^{-4}$

2nd Row:

$[Fe^*] \Rightarrow C_1V_1 = C_2V_2$
$0.0025*10 = C_2*110$
Therefore, $C_2 = (0.0025*10)/110$
$C_2 = 2.273 \times 10^{-4}$

$[SCN^*] \Rightarrow C_1V_1 = C_2V_2$
$0.0025*10 = C_2*110$
Therefore, $C_2 = (0.0025*10)/110$
$C_2 = 2.273 \times 10^{-4}$

3rd Row:

$[Fe^*] \Rightarrow C_1V_1 = C_2V_2$
$0.0025*10 = C2*115$
Therefore, $C_2 = (0.0025*10)/115$
$C_2 = 2.174 \times 10^{-4}$

$[SCN^*] \Rightarrow C_1V_1 = C_2V_2$
$0.0025*15 = C2*115$
Therefore, $C_2 = (0.0025*15)/115$
$C_2 = 3.261 \times 10^{-4}$

Etc.

Using Monday Data:

	1	**2**	**3**	**4** (Col 2 + Col 3)	**5** (Col 1 x Col 4)
Soln #	**A**	**[Fe*]**	**[SCN*]**	**[Fe*] + [SCN*]**	**A([Fe*] + [SCN*])**
1	-log (0.998) =0.000869	0.0002475	0.00002475	0.0002723	2.36734E-07
2	-log (0.994) 0.002613	0.0002451	0.00004902	0.0002941	7.6871E-07
3	-log (0.990) 0.004364	0.0002427	0.00007282	0.0003155	1.37724E-06
4	-log (0.988) 0.005243	0.0002404	0.00009615	0.0003365	1.76449E-06
5	-log (0.985) 0.006564	0.0002381	0.00011905	0.0003571	2.3442E-06
6	-log (0.984) 0.007005	0.0002358	0.00014151	0.0003774	2.64336E-06
7	-log (0.981) 0.008331	0.0002336	0.00016355	0.0003972	3.30904E-06
8	-log (0.979) 0.009217	0.0002315	0.00018519	0.0004167	3.84055E-06
9	-log (0.973) 0.011887	0.0002294	0.00020642	0.0004358	5.18018E-06
10	-log (0.968) 0.014125	0.0002273	0.00022727	0.0004545	6.42029E-06
UNK	-log(0.508) = 0.29413	X?			

With this data, when we plot [Fe*] vs. A, we get y = -586.57x + 0.1461. If we plug in 0.29413 for y, then we get a negative value for concentration: x = -0.000252. This does not make sense and so the data is probably too close together. So for the later sections we increased the amount of KSCN added to see what effect it would have. (Note: The trendline fits the data well: 96.83%.)

Unknown Concentration

$y = -586.57x + 0.1461$
$R^2 = 0.9683$

Absorbance vs. Concentration [Fe*]
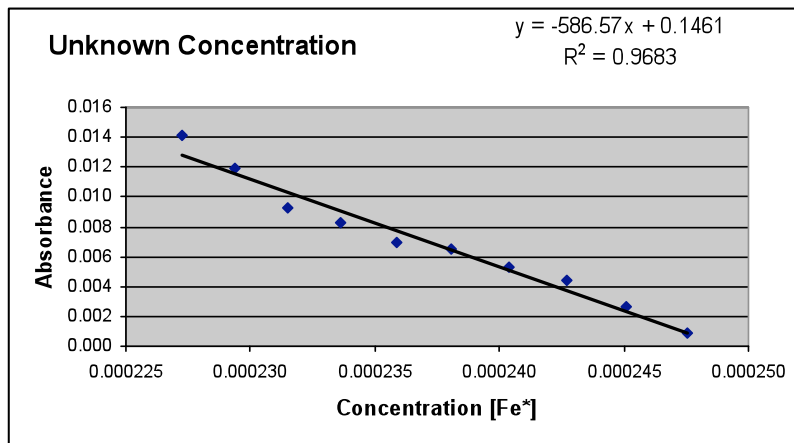
What we should have asked you to plot was the concentration of thiocyanate [SCN*] vs. A. For this plot, we get y = 58.657x – 0.0005. So when we plug in A = y = 0.29413, then x = 0.0050. This answer makes a lot more sense.

Unknown Concentration

$y = 58.657x - 0.0005$
$R^2 = 0.9683$

Absorbance vs. Concentration [KSCN*]
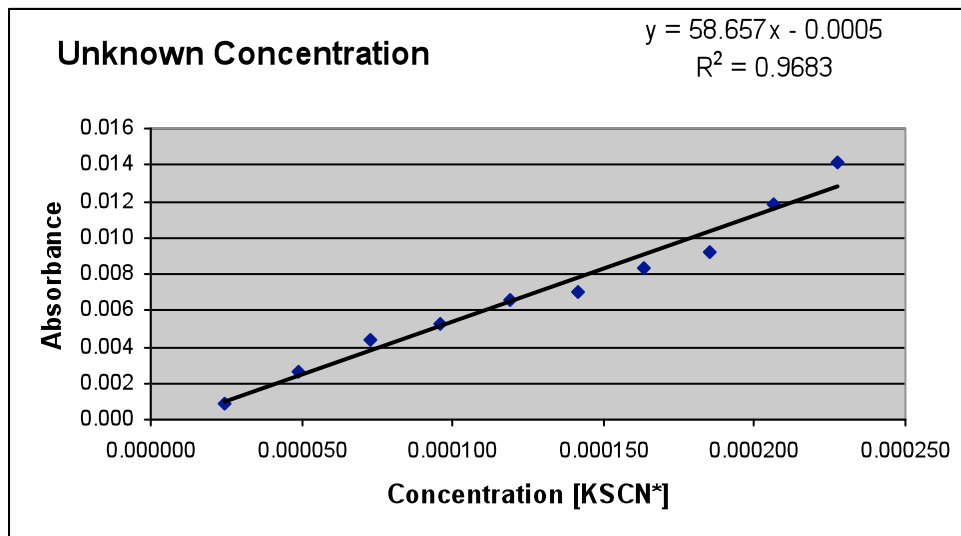
However, you were not asked to do this.

For the K$_{eq}$ plot.

	4 (Col 2 + Col 3) [Fe*] + [SCN*]	5 (Col 1 x Col 4) A([Fe*] + [SCN*])	6 (Col 2 x Col 3) [Fe*] [SCN*]	7 (Col 5 / Col 6) = x (A([Fe*] + [SCN*])) / ([Fe*] [SCN*])	8 (Col 1 / Col 6) = y (A / [Fe*] [SCN*])
1	0.0002723	2.36734E-07	6.12685E-09	39	141910
2	0.0002941	7.6871E-07	1.20146E-08	64	217536
3	0.0003155	1.37724E-06	1.76737E-08	78	246967
4	0.0003365	1.76449E-06	2.31139E-08	76	226836
5	0.0003571	2.3442E-06	2.83447E-08	83	231570
6	0.0003774	2.64336E-06	3.33749E-08	79	209886
7	0.0003972	3.30904E-06	3.82129E-08	87	218015
8	0.0004167	3.84055E-06	4.28669E-08	90	215021
9	0.0004358	5.18018E-06	4.73445E-08	109	251078
10	0.0004545	6.42029E-06	5.16529E-08	124	273453
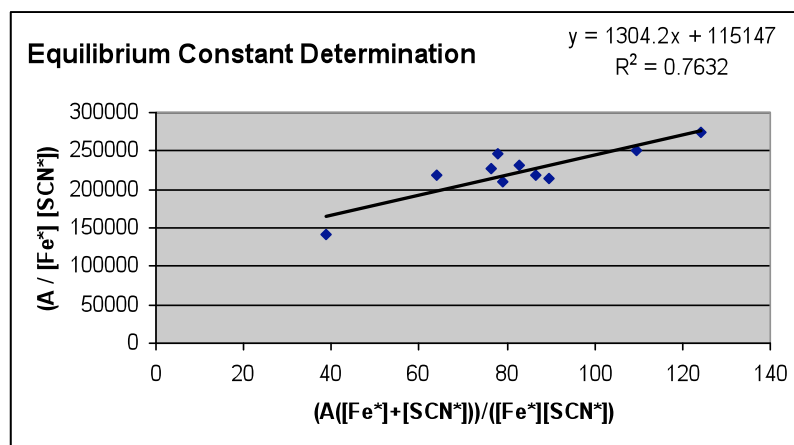
For this plot, the K$_{eq}$ value is equal to the slope: 1304.2. As you can see there was a lot of scatter in the data. The trendline only fits 76.32% of the data. This gives us little confidence in the generated K$_{eq}$ value. Again we will try and resolve this by increasing the amount of KSCN added.