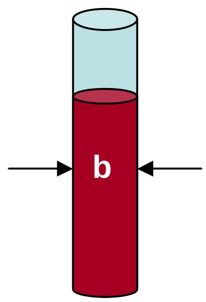
Assume that at the concentrations we are using, the following is the only equilibrium that matters.

	$Fe^{+3}(aq)$	+ $SCN^{-}(aq)$	$\rightleftharpoons$ **$Fe\text{-}SCN^{2+}(aq)$**
Initial	[Fe*]	[SCN*]	0
Change	-x	-x	x
Equilibrium	[Fe*] - x	[SCN*] - x	x

Initially there is no Fe-SCN complex, but it forms in order to establish this equilibrium. To do this, some of the original Fe^{+3} and SCN^{-} (x each) must be consumed.

$$K_C = \frac{[FeSCN^{2+}]_{eq}}{[Fe^{+3}]_{eq}\,[SCN^{-}]_{eq}}$$

Bright red $FeSCN^{2+}$ absorbs light at 447 nm.



cuvette

b is the path length that the light beam travels through. This is a constant and in this case is 1 cm.

ε is the molar absorptivity of the $FeSCN^{+2}$ complex at 447 nm. It too is a constant at this wavelength for this system.

A_{447} is the absorbance of $FeSCN^{+2}$ at this wavelength. This is directly related to concentration according to the equation

$$A = \varepsilon\, b\, [FeSCN^{+2}]$$

Rearranging this equation gives

$$[FeSCN^{2+}]_{eq} = x = \frac{A_{447}}{\varepsilon b}$$

$$[Fe^{3+}]_{eq} = [Fe^*] - x$$

$$[SCN^{-}]_{eq} = [SCN^*] - x$$

Plugging these into our K_C expression gives

$$K_C = \frac{x}{([Fe^*] - x)\,([SCN^*] - x)} = \frac{x}{[Fe^*][SCN^*] - [Fe^*]x - [SCN^*]x + x^2}$$

Experience has shown that ε for $FeSCN^{+2}$ is an enormous number, about 10,000 times larger than A_{447}. Given this idea

$$x = \frac{A_{447}}{\varepsilon b} = \text{very small (not zero, but very small)}$$

This means that $x^2 \sim 0$ or small enough to neglect in the expanded K_C expression above.

$$K_C = \frac{x}{[Fe^*][SCN^*] - [Fe^*]x - [SCN^*]x + x^2} \sim \frac{x}{[Fe^*][SCN^*] - [Fe^*]x - [SCN^*]x}$$

Collect terms in the denominator on the right

$$K = \frac{x}{[Fe^*][SCN^*] - ([Fe^*]+[SCN^*])x}$$

Cross multiply

$$K\left([Fe^*][SCN^*] - ([Fe^*]+[SCN^*])x\right) = x = K[Fe^*][SCN^*] - K\,x\,([Fe^*]+[SCN^*])$$

The real expression for x needs to be substituted at this point ($x = A/\varepsilon b$)

$$x = \frac{A}{\varepsilon b} = K[Fe^*][SCN^*] - K\frac{A}{\varepsilon b}([Fe^*]+[SCN^*])$$

Multiply through by εb

$$A = K\varepsilon b\,[Fe^*][SCN^*] - K\,A\,([Fe^*]+[SCN^*])$$

Divide through by [Fe*][SCN*], reorder terms on the right.

$$\frac{A}{[Fe^*][SCN^*]} = -K\frac{A\,([Fe^*]+[SCN^*])}{[Fe^*][SCN^*]} + K\varepsilon b$$

This is now a linear equation if you look carefully.

$$\underbrace{\frac{A}{[Fe^*][SCN^*]}}_{\mathbf{y}} \;\mathbf{=}\; \underbrace{-K}_{\mathbf{m}}\;\underbrace{\frac{A\,([Fe^*]+[SCN^*])}{[Fe^*][SCN^*]}}_{\mathbf{x}} \;\mathbf{+}\; \underbrace{K\varepsilon b}_{\mathbf{b}}$$