EXPERIMENT 3
Quantitative Analysis of Fe(III)-Oxalate Complex

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SPECTROPHOTOMETRY: A QUANTITATIVE TECHNIQUE

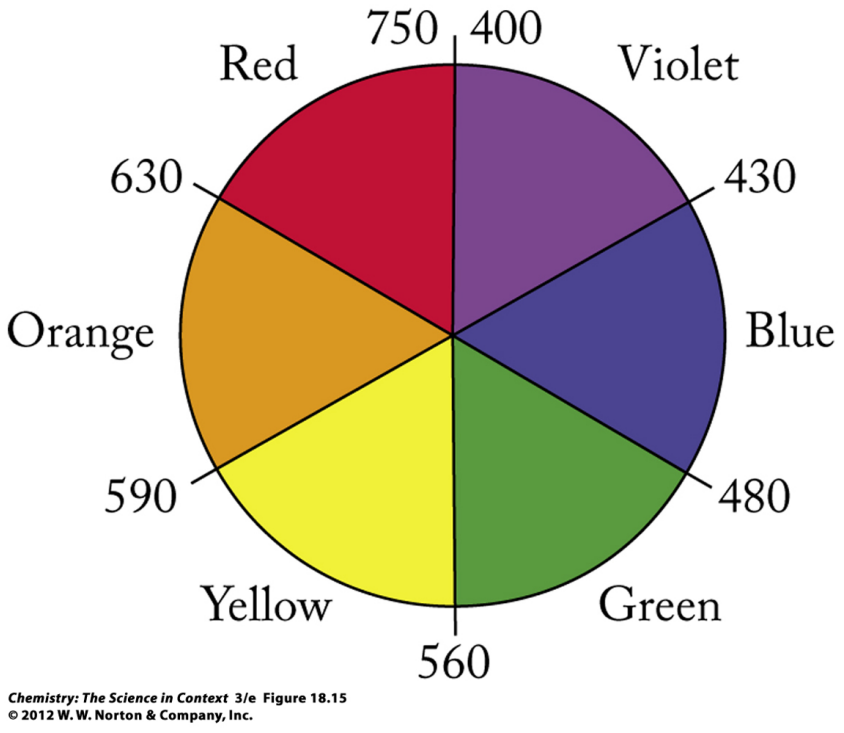
Light absorption and color of things

COMPLEMENTARY COLORS:

R/G O/B Y/P

If a chemical species is **RED**, it will strongly absorb **GREEN** light.

It may absorb other colors too.



Chemistry: The Science in Context 3/e Figure 18.15

The experimental quantity of interest is Absorbance (A)

$$A = -\log\left[\frac{I_t}{I_0}\right]$$

where, I_0 = amount of light going in
I_t = amount of light coming out after absorption

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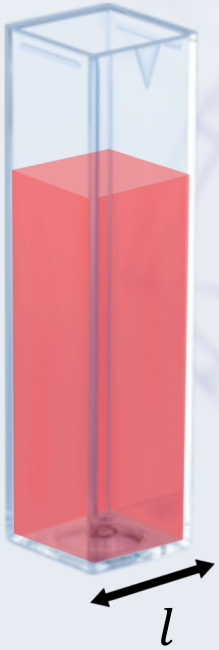
Measure I_0 using a BLANK
Measure I_t using the SAMPLE



BEER-LAMBERT LAW

$$A = \varepsilon c l$$

A = absorbance (dimensionless)
c = concentration ($mol \cdot L^{-1}$)
l = pathlength (cm)
ε = molar absorptivity ($mol^{-1} \cdot L \cdot cm^{-1}$)

SPECTROPHOTOMETRY: THE BASIC IDEAS

Convert the species of interested to another intensely colored species.

PART 1. Spectrophotometry of Fe(II)

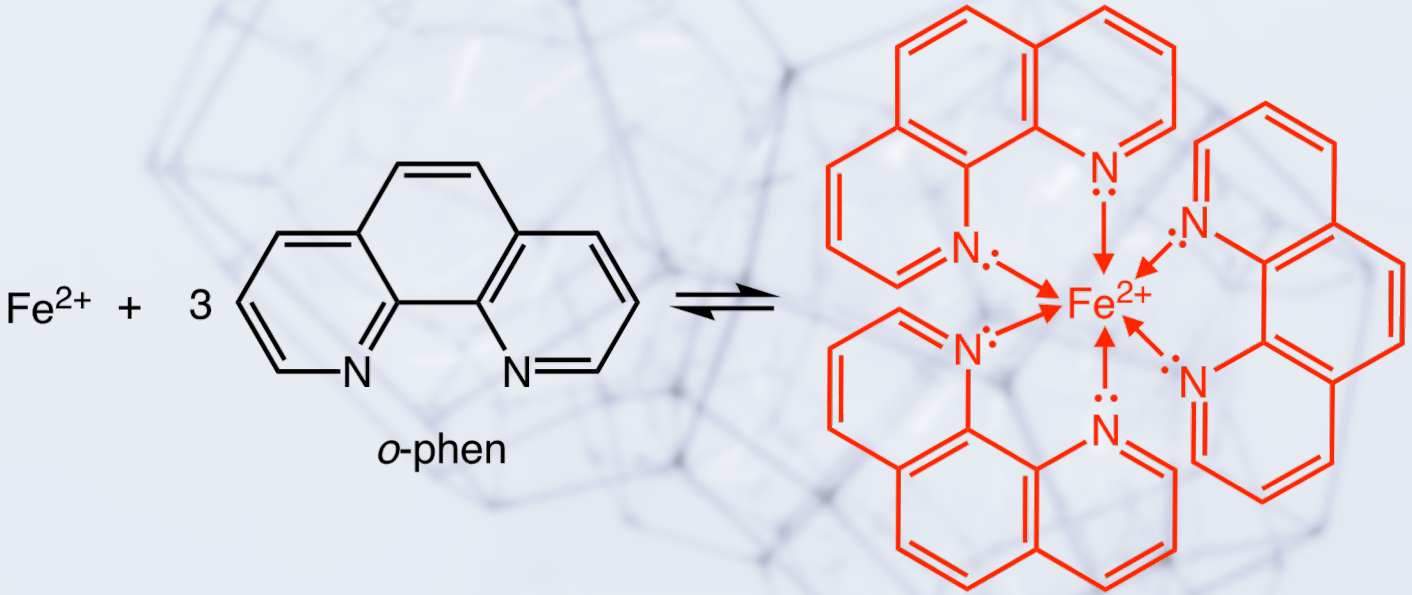
Fe^{2+} (*aq*) + 3 *o*-phen (*aq*) → $[Fe(o\text{-phen})_3]^{2+}$ (*aq*)

COLORLESS COLORLESS

To make sure all Fe is in 2+ state, we use hydroxylamine.

To adjust pH to the optimal value, we use sodium acetate.

Fe^{2+} (*aq*) + 3 *o*-phen (*aq*) → $[Fe(o\text{-phen})_3]^{2+}$ (*aq*)



Prepare several calibrating solutions containing known concentrations of the colored complex

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Measure absorbances

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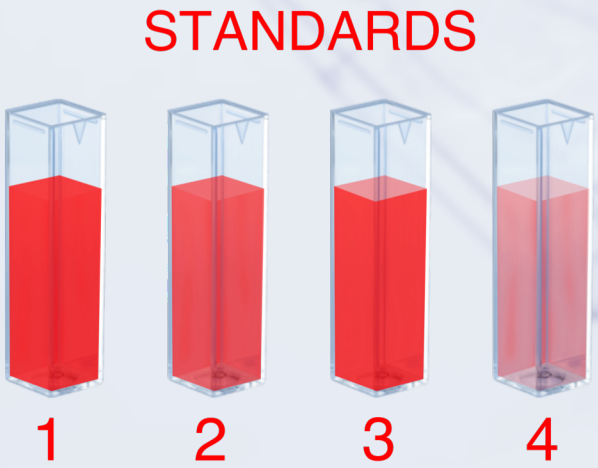
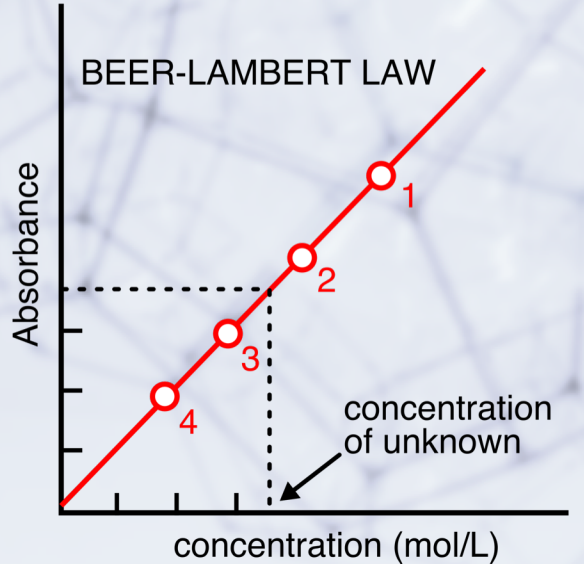
Plot calibration graph → ε = slope





VERNIER SPECTROMETER

PART 2. Mass % of Fe in Fe(III)-oxalate complex

Take a known mass of the complex from Expt. 1

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Reduce all the Fe(III) into Fe(II)
Adjust the pH
Complex with *o*-phen

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Measure absorbance

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Use the calibration curve to figure out [Fe] → mass %

PART 3. Mass % of oxalate in the same complex

$$5\ C_2O_4^{2-}\ (aq) + 2\ MnO_4^-\ (aq) + 16\ H^+\ (aq) \rightarrow 2\ Mn^{2+}\ (aq) + 10\ CO_2\ (g) + 8\ H_2O\ (l)$$

Take another known mass.
Dissolve in water.
Add H_2SO_4.
Titrate with MnO_4^- of known molarity.