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Lab 2: Visible Spectroscopy

Abstract

Beer's Law allows us to analyze the effects of concentration and molar absorbancy on absorbance. This was used to determine the relationship between a solution's concentration and absorbance to find the concentration of an unknown solution. To do this, the absorbance and concentrations were found for a total of 5 vials of varying concentrations. Once all the concentrations were found, a spectrometer was used to determine each solution's absorbances and the unknown. Upon attaining the concentrations and absorbances of each, they were plotted, and the slope of the line of best fit was used as the Molar Absorption, which was determined to be 92,534 L / (mol * cm).

Experimental

For this experiment, the relationship between concentration and absorbance was determined to find an unknown concentration. First, a total of 5 vials were labeled #1 - #5. Vial #1 contained a solution of 4 mL of $1 * 10^{-5}$ M Blue Dye and 16 mL of distilled water. Then, 10 mL of distilled water was placed in vials #2 - #5. 10 mL of solution from Vial #1 was transferred to Vial #2, thus halving the original concentration solution. The contents were now stirred to combine, and the process was repeated for the remaining vials. 10 mL of solution from Vial #2

was transferred to Vial #3 and stirred. Then Vial #3 to Vial #4, and lastly Vial #4 to Vial #5. The concentrations of each Vial are listed in *Table 1*.

Table 1: Concentrations of Blue Dye for each vial

Vial	Concentration
1	$1 * 10^{-5}$ M
2	$5 * 10^{-6}$ M
3	$2.5 * 10^{-6}$ M
4	$1.25 * 10^{-6}$ M
5	$7.5 * 10^{-7}$ M

Upon finding each concentration, disposable pipettes were used to transfer some solution into small cuvettes to be used in the spectrometer. Initially, a cuvette with distilled water was used to initialize the device; then, each cuvette was individually placed in the device to find the absorbance and lambda. These values were plotted via Excel, and the slope of the line was used as the Molar Absorption. Knowing this, the unknown solution's concentration could be determined using *Equation 1.*

Results and Discussion

The trend shows that as the concentration increases, so does the absorbance. The higher the molar absorbancy is, the higher the potency of the given solution is. Graphing the values in *Table 2* leads to *Graph 1,* where the slope was *92,534*. This value is the Molar Absorbance times the length, 1 cm. This shows that the solution's molar absorbance is *92,534 L / (mol * cm); however*, this value could be inaccurate due to the equation initially having a y-intercept value of

0.0069. Blue dyes are usually around *70,000 L / (mol * cm)*. This value was used in *Equation 1* to find the concentration of the unknown solution given its absorbancy. The error could likely reside in differences in concentration due to improper fluid transfer.

*Equation 1: Absorbance = Molar Absorbance * length * Concentration*

$$A = \varepsilon * l * C$$

Equation 2: Determining the unknown concentration using Equation 1

$$0.35 = 92,534\ L / (mol * cm) * 1\ cm * C$$

$$3.78 * 10^{-6}\ mol / L = C$$

Table 2: Absorbance and Lambda for each vial

Vial	Absorbance	Lambda	Concentration
1	0.92	631 nm	$1 * 10^{-5}$ M
2	0.45	632 nm	$5 * 10^{-6}$ M
3	0.23	629 nm	$2.5 * 10^{-6}$ M
4	0.11	633 nm	$1.25 * 10^{-6}$ M
5	0.06	632 nm	$7.5 * 10^{-7}$ M
Unknown B	0.35	633 nm	Unknown M

Graph 1: Graph shows the relation between concentration and absorbance for the given dye