ABSORPTION COEFFICIENT CALCULATION OF POTASSIUM CHROMATE (K_2CRO_4) SOLUTION

Abstract

The concentration and absorption coefficient of potassium chromate (k2CrO4) were plotted on a graph along with wavelength and absorbance using a double-beam UV/VIS spectrophotometer to analyze the absorption spectrum. Utilizing a cuvette containing concentrated potassium chromate and distilled water as a reference, absorbance was measured at various wavelengths. Sample cell contains .207 moles per liter the amount of potassium chromate as measured at 626 nm in wavelength.

Keyword: Dual Beam UV-Visible Spectrophotometer

Authors

Dr. Harikrishna Semwal
Assistant Professor
Department of Physics
Government Degree College Satpuli Pauri Garhwal
Uttarakhand, India.
drhksemwal@gmail.com

Professor Subhash Chandra Bhatt
Professor
Department of Physics
HNB Garhwal Central University Srinagar Garhwal , Uttarakhand , India.
scbhattin@yahoo.com

I. INTRODUCTION

The study of how electromagnetic radiation and matter interact is the focus of this scientific field. It is the most potent tool currently available for studying atomic and molecular structures and is employed in the analysis of a variety of sample [1-2]. The electromagnetic spectrum is the collection of all observed frequencies and photon wavelengths. According to frequencies and wavelengths, electromagnetic radiation is distributed specifically in the electromagnetic spectrum[3]. Electromagnetic waves have a wide range of frequencies, wavelengths, and photon energies. In a vacuum, they move at the speed of light. Most physicists up until the 20th century thought this spectrum was infinite and continuous. The study of light propagation through matter is the most significant and fascinating aspect of spectroscopy[4]. In spectroscopy, all forms of electromagnetic radiation can be used to describe matter and study it. Light that is passes through the substance, a particular wavelength is absorbed. For a given wavelength, the intensity and rate of light absorption are inversely related. In other words, because some light is absorbed as it travels through the substance, the intensity of the light decreases. Because of this, the wavelength and distance traveled affect the intensity at a given point in the substance[5]. How far a specific type of light wave can pass through a substance before it is absorbed depends on the absorption coefficient. A substance with a low absorption coefficient absorbs light at a lower wavelength. It appears transparent to that particular wavelength if the substance is that thin. The wavelength of the light being absorbed as well as the material have an impact on the absorption coefficient.

In this paper the absorbance and concentration of Potassium chromate solution is measured. Absorption coefficient is calculated using absorbance and plotted the graph between concentration vs. absorption coefficient and result is discussed.

1. Potassium chromate Properties

- The potassium chromate is oxidizing agent
- Appearance: Powder, contain yellow color
- Chemical formula: K_2CrO_4
- Molar Mass: 194.19 $g.mol^{-1}$
- Boiling point: 1,000 °C (1,830 °F; 1,270 K)
- Density: 2.7320g/cm^3
- Melting Point: 968 °C (1,774 °F; 1,241 K)
- Magnetic Susceptibility: -3.9×10^{-6} cm^3/mol
- Refractive Index: 1.74
- Crystal Structure: Rhombic

2. Absorption Coefficient Calculations: The absorption coefficient α is calculated from UV-Vis absorbance data , The transmitted intensity is equal to the incident intensity's exponentially decaying intensity, according to Beer's Law of Lambert. If x represents the solution's thickness or the length of the cuvette through which the intensity is moving. By combining the logarithms of the two sides and using this relationship, which is equal to $-\alpha$ x loge, put value of loge is .4343. The term $Log(I_o/I)$ is called absorbance A, So applying this logarithmic relation, absorbance is equal to αx times .4343. Putting x = 1 cm as dimension of a length of cuvette. Thus from the UV-Vis absorption data. The columns in the table 1.1 shows the wavelength, absorbance and absorption coefficient[6] .

From lambert law

$I = I_o e^{-\alpha x}$

$I/I_o = e^{-\alpha x}$

$\log(I/I_o) = \log(e^{-\alpha x}) = -\alpha x \log(e) = -\alpha x(.4343)$ where $\log e = .4343$

$\log(I_o/I) = A = \alpha x(.4343)$

$\alpha = 2.302\ A/x$ length of cubette x = 1 cm

So absorption coffcient $\alpha = 2.302\ A\ cm^{-1}$

3. **Molarity Calculations:** Molar concentration is known as molarity. The ratio of a substance's moles to its total volume, including both the solute and the solvent, is known as its molarity. It is customary to use litres to measure solution volume. The mole per litre is the unit of molarity.

Wavelength range = 396 -700 nm
Molecular weight of potassium chromate = 194.1926 gm
Quantity taken (potassium chromate) = 2.51 gm
Water (distilled) = 60 ml
Weight of solution = 62.51 ml = .06251 litre

$$\text{Molarity} = \frac{\text{no. of mole}}{\text{solution(in litr)}}$$

$$\text{No. of moles} = \frac{2.51\ \text{gm}}{194.1926\ \text{gm}} = 0.01292$$

$$\text{Molarity} = \frac{0.01292}{62.51} \times 1000$$

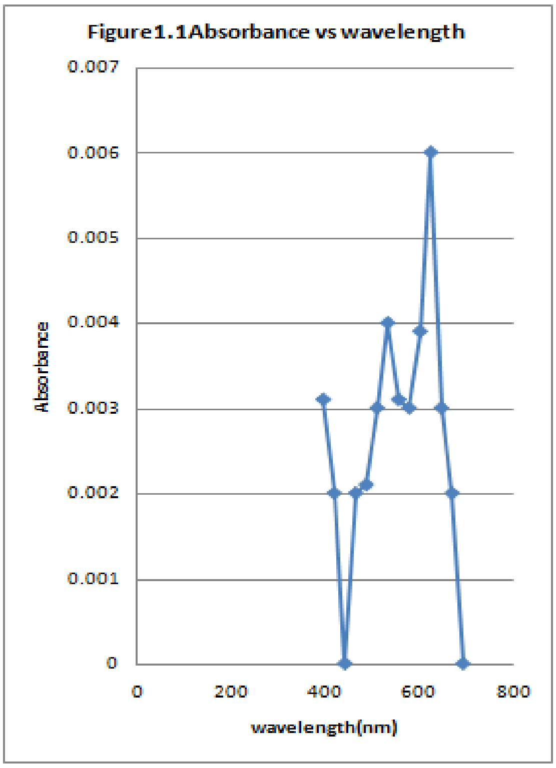
$$= 0.207\ \text{mole/litr}$$

4. **Concentration Calculations:** Concentration and molarity are two important terms, these both the terms are used to indicate quantitative measurement of a substance. The expression of concentration through molarity. The difference between concentration and molarity is that the former refers to the amount of solutes in a solution while the latter is a way to express concentration. To evaluate the concentration of the solution, the solution is diluted with water in different compositions and the total volume is taken 5ml. The molarity of solution is .207 mole /litre. The relation between molar concentration and volume $m_1v_1 = m_2v_2$ is used to calculate the concentration of mixed solution and values are tabulated.

II. OBSERVATION

Table 1.1: Absorbance And Absorption Coefficient for Different Values of Wavelength

Wavelength (nm)	Absorbance	Absorption coefficient $\alpha = 2.302\ A/x\ cm^{-1}$
396	0.0031	.0071362
419	0.002	.004604
442	0.000	.000
465	0.002	.004604
488	0.0021	.009208
511	0.003	.006906
534	0.004	.009208
557	0.0031	.0071362
580	0.003	.006906
603	0.0039	.0089778
626	0.006	.013812
649	0.003	.006906
672	0.002	.004604
695	0.000	.000



Wavelength fixed = 626 nm,
Maximum wavelength= 700 nm
Total solution taken = 5ml

Table 1.2: Absorbance & Absorption Coefficient for Different Concentration of The Solution

S.No	Solution(ml)	Water (ml)	Absorbance	Absorption coefficient	Concentration (final)
1	1	4	0.040	.0928	0.041
2	2	3	0.041	.094382	0.082
3	3	2	0.042	.096684	0.124
4	4	1	0.043	,098986	0.166

III. RESULTS

The concentration of the substance determines the amount of light it can absorb. Absorption coefficient is decreases as the concentration is decreased . The light is poorly absorbed in a substance if the absorption coefficient is low, and if the substance is thin enough, it will appear transparent to that wavelength. At wavelength 626 nm maximum Absorbance is 0.006 and maximum absorption coefficient is .013812.

According to Table 1.1 and Figure 1.1, there are two maxima: one at 534 nm, where absorbance is 0.004, and another at 626 nm, where absorbance is 0.006. The sum of the two absorbances is then equal to $\frac{0.004+0.006}{2} = 0.005$. The values of absorbance and absorption coefficient for various concentrations are measured at wavelength 626nm. From table1.2 &figure1.2 shows that for a constant wavelength of 626 nm in the solution, the absorption coefficient rises linearly with concentration.

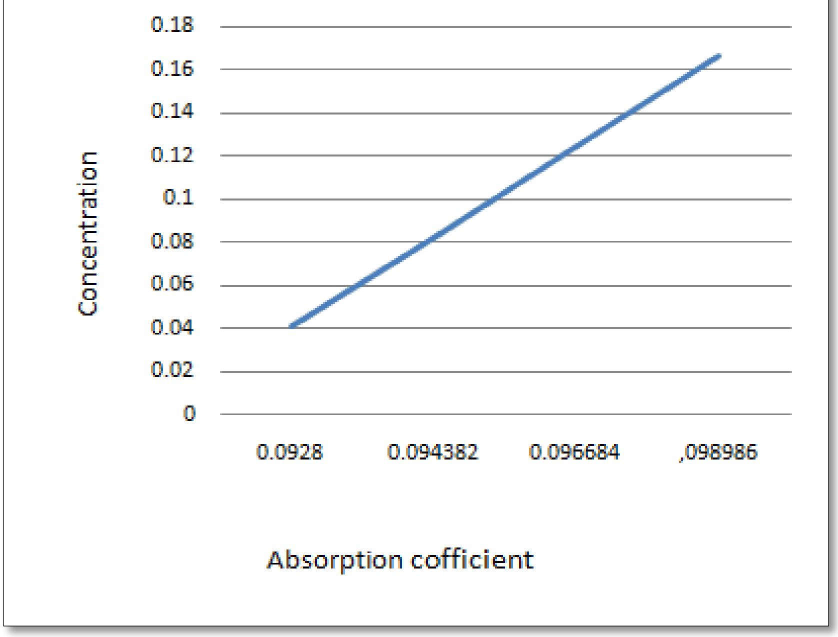


Figure1.2 Graph Absorption cofficient vs concentration

REFERENCES

[1] Chatwal GR, Anand S Instrumental method of Chemical Analysis (5th edn), Himalaya Publishing House, New Delhi (2002).
[2] Allen, D., Cooksey, C., & Tsai, B. (2010, October 5). Spectrophotometry Retrieved.
[3] H.K. Semwal, International journal of Research in Engineering and Science (IJRES) pg.133-135
[4] Goetzberger, Adolf et.al. Crystalline Silicon solar cells.Chichester,John Wiley&Sons Ltd.,1998.
[5] Willard-Hobart H, Merritt jr Lynne L, Dean John A(1974) Instrumental
[6] Methods of Analysis.(5th edn),Von Nostrand,University of Michigan.
[7] Absorption coefficient calculations from UV-Vis absorbance data in origin.SAYPhysics.