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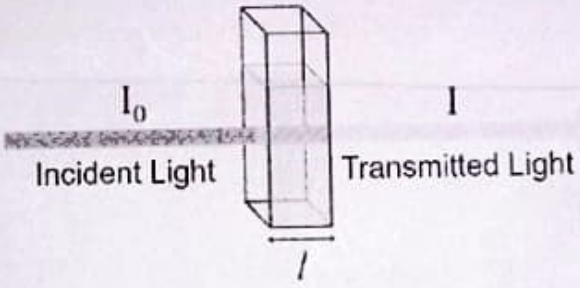
AIDS-B2
'076

LAB MANUAL: EXPERIMENT 2

Aim: To verify Lambert-Beer's law using a given solution of potassium dichromate at the wavelength of its maximum absorption (λ_{max}) and consequent determination of the unknown concentration of a solution of potassium dichromate.

Theory:

The Beer-Lambert law states that the absorbance of a solution is directly proportional to the concentration of the absorbing species in the solution and the path length. Thus, for a fixed path length (cuvette length), UV/Vis spectroscopy can be used to determine the concentration of the absorber in a solution. The absorbance changes with concentration. Thus, a higher concentration of the colored solution absorbs more light (and transmits less) than a solution of lower concentration.



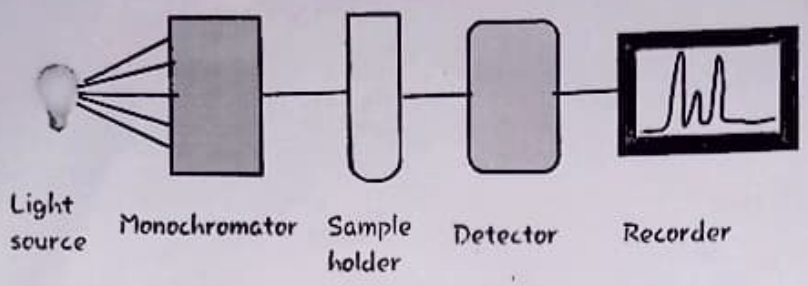
$$\log (I_o / I_t) = A = \varepsilon c l$$

According to Beer–Lambert law,

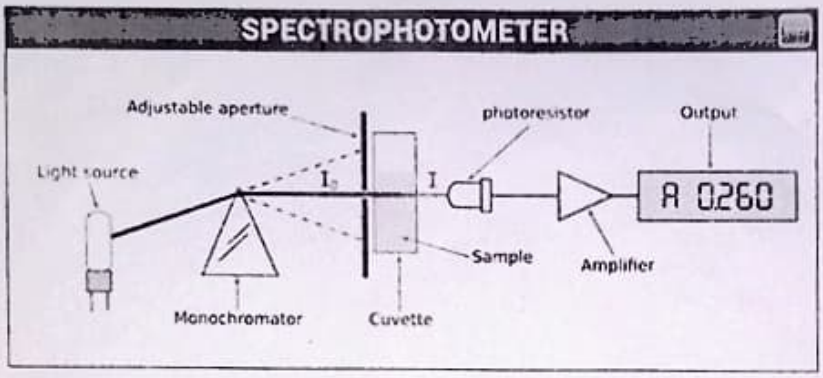
$\log(I_o/I_t)=A=\varepsilon cl$ where I_o and I_t are the incident and transmitted intensities,

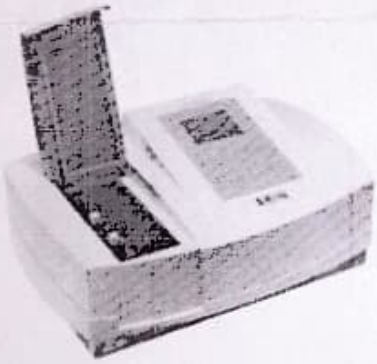
A = absorbance and ε is a constant i.e. absorptivity (also called the extinction coefficient).

If the concentration is measured in $molL^{-1}$, the absorptivity is called molar absorptivity. $A= \varepsilon cl$. At constant length $A \propto c$

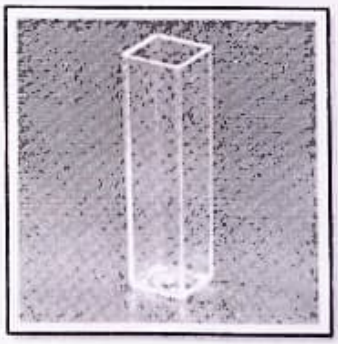


Working principle of spectrophotometer





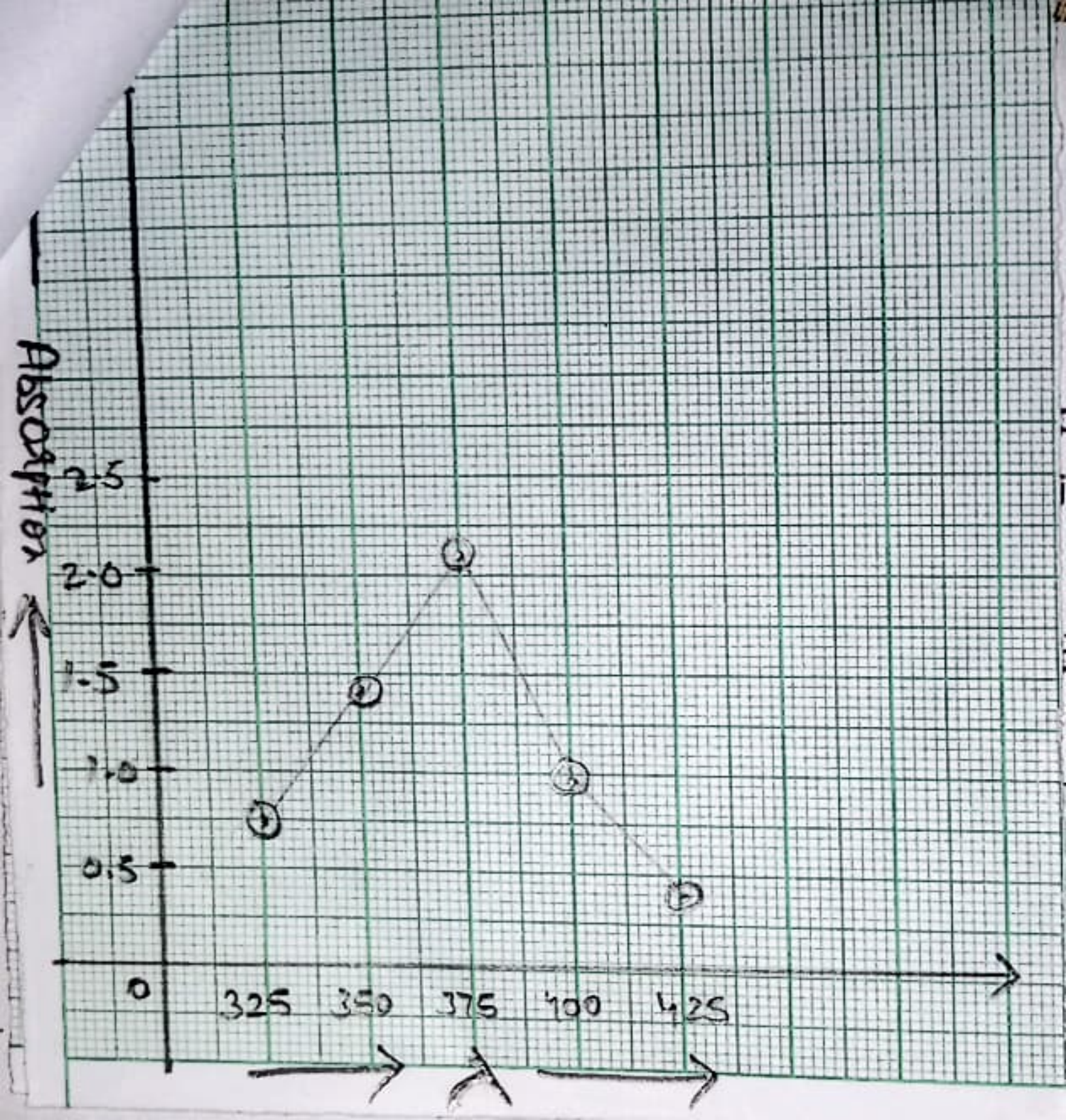
Spectrophotometer



Cuvette

Requirements:

spectrophotometer, cuvette, six test tubes, Measuring cylinder, 10 mL pipette, 0.001M $K_2Cr_2O_7$ solution, distilled water, test tube rack, and tissues (preferably lint-free).


Absorption
2.5
2.0
1.5
1.0
0.5
0
325
350
375
400
425

Procedure & observation table:

Step 1: To record the absorbance of $K_2Cr_2O_7$ solution at different wavelengths to determine the light wavelength for its maximum absorption (λ_{max}):

(a) Prepare 200 mL of 0.001M $K_2Cr_2O_7$ **(Molecular weight 294.18 gm/mol)** solution in distilled water.

(b) Label five clean, dry, test tubes 1-5.

(c) Use a 10 mL pipette to prepare five standard solutions according to Table 1.

(d) Thoroughly mix each solution.

(e) Calibrate the spectrophotometer with respect to the blank solution i.e. distilled water.

(f) Fill the first one of the prepared solutions (1-5) up to a certain level in the cuvette of the spectrophotometer.

(g) Record the absorbance of the respective solution at different wavelengths as mentioned in Table 2.

(h) Plot the absorbance data in the graph paper with respect to the wavelength and calculate the light wavelength for its maximum absorption (λ_{max}) in $K_2Cr_2O_7$.

Table 1:

Test-tube	0.001M $K_2Cr_2O_7$ (mL)	Distilled water (mL)	Concentration (M)
1	1	9	1×10^{-4}
2	2	8	2×10^{-4}
3	3	7	3×10^{-4}
4	4	6	4×10^{-4}
5	5	5	5×10^{-4}

Table 2: The solution of the ..... **No.** the test tube was chosen for the determination of the light wavelength for its maximum absorption (λ_{max}).

Entry	Wavelength (λ in nm)	Absorbance
1	325	0.799
2	350	1.386
3	375	2.168
4	400	0.946
5	425	0.329
6		

Step 2: To record the absorbance of different concentrations of solutions at the specified λ_{max}:

(a) Set the operating wavelength of the spectrophotometer in the range of absorption maxima of aqueous $K_2Cr_2O_7$ solution (λ_{max}).

(b) Calibrate the spectrophotometer with respect to water as the blank.

(c) Fill each of the solutions up to a certain level in the cuvette of the spectrophotometer.

(d) Record the absorbance of the respective solutions as stated in Table 3.

(e) Plot the absorbance data in the graph paper with respect to the concentration which should be a straight line passing through the origin.

Table 3:

Entry	Test-tube	Absorbance
1	1	1.014
2	2	1.830
3	3	2.168
4	4	2.738
5	5	2.806