

Colorimetric and Spectrophotometric methods

A group of techniques that relies on the interaction of electromagnetic radiation and matter.

There are many types of methods based on either molecular or atomic interactions.

Absorption
Emission
Fluorescence

EM radiation

Type	wavelength	Interaction
γ	< 10 nm	nuclear emission
X-ray	< 10 nm	atomic ionization
UV	10-380 nm	electronic transitions
Vis	380-800 nm	electronic transitions
IR	800nm-100 μ m	bond interaction
Radio	meters	nuclear absorption

Methods of interaction

Two types of interaction are exploited as the basis of the methods we will be looking at.

Absorption - light is absorbed by an atom, ion or molecule, taking it to a higher energy state.

Emission - the release of a photon by an atom, ion or molecule, taking it to a lower energy state.

The absorption process

Light is absorbed by a substance only when the energy corresponds to some energy need or transition of a substance.

Changes in our substance can be

- Electronic
- Vibrational
- Rotational

The last two are only seen for molecules.

Qualitative Analysis

UV/Vis, IR

Identification of a compound can be accomplished by comparing spectra to reference materials.

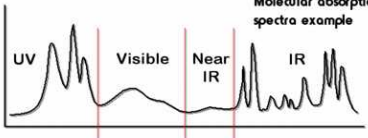
This is most often done with IR - there is much more information there.

UV/VIS are not very interesting and can be quite similar.

Spectra

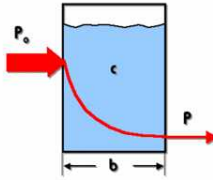
With UV, Vis, IR - absorption occurs over a range. By scanning and measuring absorption over a range of wavelengths, we can produce a spectrum.

Molecular absorption spectra example



Quantitative Analysis

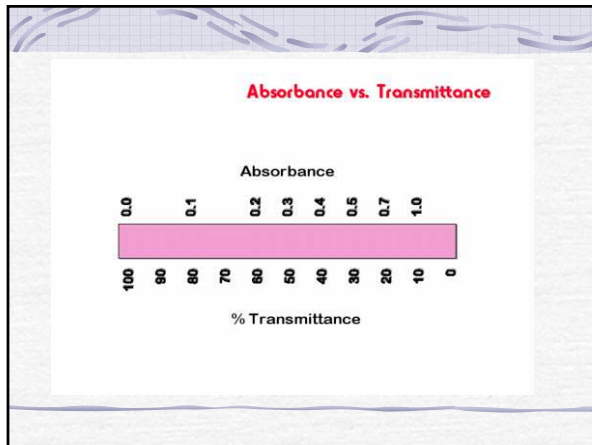
$\frac{P}{P_0}$ is a measure of the light that passes through the solution - transmitted



$\frac{P}{P_0}$ is also called the transmittance (T)

$-\log(T) = A$
A - absorbance

$A = abc$



Example two

A solution contains 4.50 ppm of a colored species. It is found to have an absorbance of 0.30 at 530 nm in a 2.00 cm cell.

Calculate a.

$A = abc$

where:

A = absorbance b = cell pathlength
a = absorbtivity c = concentration

Example three

A solution of $\text{Co}(\text{H}_2\text{O})_2^{2+}$ has an absorbance of 0.20 at 530 nm in a 1.00 cm cell. ϵ is known to be $10 \text{ L mol}^{-1}\text{cm}^{-1}$. What is its concentration.

Example four

The absorbance of an unknown MnO_4^- solution is 0.500 at 525 nm. When measured under identical conditions, a $1.0 \times 10^{-4} \text{ M MnO}_4^-$ is found to have an absorbance of 0.200.

Determine the concentration of the unknown.

Summary of equations

$$-\log \frac{P}{P_0} = abc$$

$$\log \frac{P_0}{P} = abc$$

$$-\log(T) = abc$$

$$-\log(T) = A$$

$$A = abc$$

$$A = \epsilon bc$$
