Hello students, I am Miss Shreya Avdhoot Silimkhan

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The title of the unit is UV visible

spectroscopy and the name of the

module is derivation of Beer-Lambert's law and deviations from Beers law.

So I will be discussing statement

of Beer Lambert's law, derivation of

Beer-Lambert's Law and the validity and

deviations from Beer-Lambert's law.

So upon going through this module,

the students will be able to

state the Beer-Lambert's law,

derive the Beer-Lambert's law,

understand the validity of Beer-Lambert's

law, and know the limitations of Beers law.

So coming to Beer-Lambert's law,

a combination of Lambert's law and Beers law,

it results in the Beer-Lambert's law.

So these are two separate laws,

Students, Beers law and Lambert's law when combined together,

gives us the Beer-Lambert's law.

It governs the absorption of light by

absorbing media, such as solutions.

So let us see the statement

for Beer-Lambert's law.

It states that the fraction of incident

radiation absorbed is proportional to the

number of absorbing molecules in its path.

To tell you,

in a mathematical form,

A is equal to epsilon C l.

So first I will like to start with

Lambert’s law transmission of light.

So we are coming to the derivation.

So here is a statement for Lambert’s

Law. When a monochromatic light is passed

through a pure homogeneous medium,

the decrease in the intensity of light

with thickness of the absorbing medium

at any point X is proportional to

the intensity of the incident light.

So to write it in an equation form minus d by dx is directly proportional to I,

so further minus d by dx is equal to K I.

dI is the small decrease in intensity

of the light passing through a small

thickness dx. k is the constant

of proportionality called the

absorption coefficient.

So our first equation is minus d by dx

is equal to KI.

The intensity I at any point

X at a distance x.

OK here, there are two alphabets.

Distance is denoted by the small letter X.

So the intensity I at any point capital

letter X at a distance x from the start

of the medium can be found in terms of

the original intensity given by I_0.

So equation one,

we can rewrite it as dI upon

I is equal to minus Cdx,

you have to label this as equation 2.

when X is equal to 0 then I is equal to.

I0. Integrating equation 2

between the limits.

Now we are integrating from limits X is

equal to 0 to X and I is equal to I_0 to

I. We get this equation.

Integral going from I to I_0

I / I_0 is equal to integral x

going from zero to x minus Cdx.

Then we integrate equation

2 between the limits.

X is equal to 0 to X and I

is equal to 0 to I.

So then we obtain equation 3. ln of I /I_0

is equal to minus kx.

Further, we simplify it and write

it as I / I_0 is equal to e^-kx

and equation 4,

We get it as I = I_0 X e^-kx

so this equation it expresses how

the original intensity I_0 is

reduced to intensity I after passing

through a thickness x of the medium.

Then further we take equation

3 and we write it as

$2.33 \log I/I_0 = - kx$

$\log I/I_0 = -kx/2.303$.

so equation 5 will be obtained as

$\log I/I_0 = -k'x$

Equation 6 we will obtain it as

$I = I_0 10^{-k'x}$ this is your equation

6 where k' has the value of

k' is $k / 2.303$.

It is called as the extinction

coefficient of the substance,

which is the absorbing medium.

This quantity is referred to

as absorption coefficient or

absorptivity of the substance

$-\log I/I_0$ is called.

Absorbance of the medium.

Next we come to Beers law. Students

let us see the statement.

This law states that when a monochromatic

light is passed through a solution,

the decrease in the intensity of

light with the thickness of the

solution is directly proportional

not only to the intensity of the

incident light but also to the

concentration C of the solution.

Coming to the derivation,

we write an equation.

$-dI/dx$ is directly proportional to I

X c this is your equation 1.

Next $–dI/dx = \varepsilon Ic$.

Epsilon is a constant of

proportionality and is called

molar absorption coefficient.

Its value depends upon the nature

of the absorbing solute and the

wavelength of the light which is used.

Then we again. Write

$dI/I = -\varepsilon\ c\ dx$

then again like how we did for Lambert’s law

again we integrate the equation

between the limits X is equal to 0

to X and I is equal to a zero to I.

So upon integrating we obtain

equation 2. $\ln I/I_0 = -\ \varepsilon\ c\ dx$

Then equation 3 you will obtain

it as $I/I_0 = e^{-\varepsilon cx}$

And equation 4 is $I = I_0\ e^{-\varepsilon cx}$

This equation expresses how the

intensity of a monochromatic light

falls from I_0 to I on passing

through a thickness x of a solution

of concentration C.

$2.33 \log I/I_0 = -\varepsilon cx$

Next we simplify it

$\log I/I_0 = -\varepsilon cx/2.303$

This is equation 5

$\log I/I_0 = -\varepsilon' cx$

$\varepsilon' = \varepsilon/2.303$

Earlier this was referred to

as molar extinction coefficient

of the absorbing solution.

But now this quantity is called

molar absorption coefficient or you

can call it as molar absorptivity

of the absorbing solution.

So here I have put up a diagram showing

a cuvette and you can see the incident light.

It is referred to as I_0 and

upon passing through the cuvette,

through the solution it is referred to as I.

And you can also see the length of

the cuvette and c refers to the

solution which you have placed in the cuvette.

C is the concentration

of the solution in the cuvette.

Coming to deviations from Beers law.

The linear relationship between optical

density and concentration of solution

is not observed at concentrations above 10^-2 molar.

Hence concentrated solutions do

not obey Beer-Lambert’s equation.

The law is not obeyed if the absorbing

species reacts with the solvent,

dissociates or associates in the solution.

The molecules of the absorbing species.

They should remain as simple molecules

and they should not undergo any kind

of change in the molecular condition.

And temperature fluctuations

and entry of stray light into the

absorbing system can also lead to

deviations from Beer-Lambert's law.

The light incident,

This is the most important point.

The light incident on the absorbing

medium should be monochromatic,

otherwise minor deviations from

Beer-Lambert law are observed.

This is why monochromators have to be

used to produce monochromatic beams.

The molar extinction coefficient.

It depends on the refractive

index of the absorbing medium.

At high concentrations this

changes are considerable,

but at concentrations below

10^-2 molar,

this changes can be neglected.

When Beer-Lambert law is obeyed,

the calibration plot will be obtained as a

straight line passing through the origin.

If there are deviations

from Beer-Lambert’s law,

the calibration plot will curve either.

Upward,meaning it will be known as

a positive deviation,

and if the calibration plot

curves downward,

it will be known as a negative deviation.

So here I have put up two diagrams

showing the calibration plot,

absorbance versus concentration,

and on the left hand side you can

see a calibration line showing the

relationship between absorbance and

concentration on the right hand side.

You can see the deviations.

Positive deviation is if the plot is pointing upward and negative

is when the plot is pointing downward.

So coming to validity of Beer-Lambert’s law.

This law is strictly applicable

to dilute solutions and the

concentrations of the solution.

They have to be below 10 ^-2 molar,

so such solutions they obey the

equation. Optical density or you

can call it as absorbance is

equal to minus log to the base.

10 of T is equal to epsilon,

Cl. According to this equation,

the optical density is proportional

to the concentration of the solution

and transmittance is inversely

proportional to the concentration.

So coming to the summary of this module,

a combination of Lambert law with the Beers,

law results in the Beer-Lambert’s law.

So this law states that fraction

of incident radiation absorbed

is proportional to the number of

absorbing molecules in its path.

A is equal to epsilon, CL.

Concentrated solutions do not

obey Beer-Lambert equation.

And when Beer-Lambert law is obeyed,

the calibration plot will be obtained

as a straight line passing through the

origin and the last point is the Beer-Lambert’s

law is strictly applicable to dilute.

Solutions whose concentrations are

below 10 ^-2 molar,

So this are the references Thank

you so much for listening.