COLORIMETER
AND
LAMBERT'S-BEER'S LAW

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TOPIC

- What is colorimeter?
- Use of colorimeter.
- Component & It's function.
- Function of colorimeter.
- The principle of colorimeter.
- LAMBERT'S-BEER'S LAW
- Advantage & Disadvantage of single cell photometer.

Beer's & Lambert's Law

- The amount of light absorbed or transmitted by coloured is in accordance with the Beer's & Lambert's Law.
- **Beer's law** : It states that the intensity of the colour is directly proportional to the concentration of coloured particle in the solution.
- **Lambert's Law :**It states that the amount of the light absorbed by a coloured solution depends on the length of the column or the depth of the liquid through which light passes.
- The Beer & Lambert Law combines these two laws.

WHAT IS COLORIMETER ?

Colorimeter is works on principle of photometry

A colorimeter is a device used to test the concentration of a solution by measuring its absorbance of a specific wavelength of light.

FUNCTION OF A COLORIMETER

Color is the combination of wavelengths of varying strength to produce a sum light frequency.
For example, the color white is the equal presence of all wavelengths across the visible light spectrum.

The basic function of a colorimeter is to determine what quality of color is emitted from solution.

In colorimetric determinations

A specific reagents are used which react with the specific component and form a colored complex.

The concentration of the colored complex is directly proportional to the concentration of the component in the specimen.

That colour density absorbed specific spectum of light and rest of light get transmitted from speciment.

That transmitted light is detected by colorimeter detector.
According to following formula, Optical density is calculated.
O.D. = 2 – log %T
O.D. is directly proportional to concentration of substance.

THE COMPONANT OF COLOROMETER

- Light source
- Cuvette
- Filter (Monochrometor)
- Colored solution
- Phototube
- Galvanometer
- Amplifier & Recorder

FUNCTION OF EACH COMPONANT

Light source

Two kinds of lamp.

1. **Halogen Deuterium**
    - **for measurement in the ultraviolet range 200 – 900 nm**
2. **Tungsten lamp**
    - **for measurement in the visible 400 – 760 nm and near-infrared ranges**

CUVETTE (Sample cell):

- As per lamber – beer's law,pathlength is fixed to 1 cm.
- Sample cell has 1 cm diameter.
- A container that contains a sample is usually called "cell“
- two types are available
  1. Glass
     - wavelength of 340 nm or less hardly passes through a glass cell. It absorbed in glass cell.
     - Cheap
  2. Quartz cells
     - It allows passage of light in the entire wavelength in the ultraviolet and visible ranges.
     - Used for the measurement in the ultraviolet range
     - Costly

MONOCHROMOTOR :

FILTER:

Used for selecting the monochromatic light.
Filters will absorb light of unwanted wavelength and allow only monochromatic light to pass through.
Three Types:

1. Prism
2. Grating
3. Coloured solution

PRISM

•Wide rande of spectrum of 175-2700 nm.

•The actual separation between two wavelengths depends upon the dispersive power of prism.

COLORD SOLUTION

•A solution has color.

•Lesser proportion of the color represented by it.

•For example ,

- A blue solution appears blue because when white light passes through it, large proportion of blue light will be transmitted.

GRATINGS :

•This devises separate the various wavelengths of radiant energy as produced by a tungsten lamp by refraction or diffraction and from the spectrum produced,

•Desired wavelength selected by the adjustment of an exit slit.

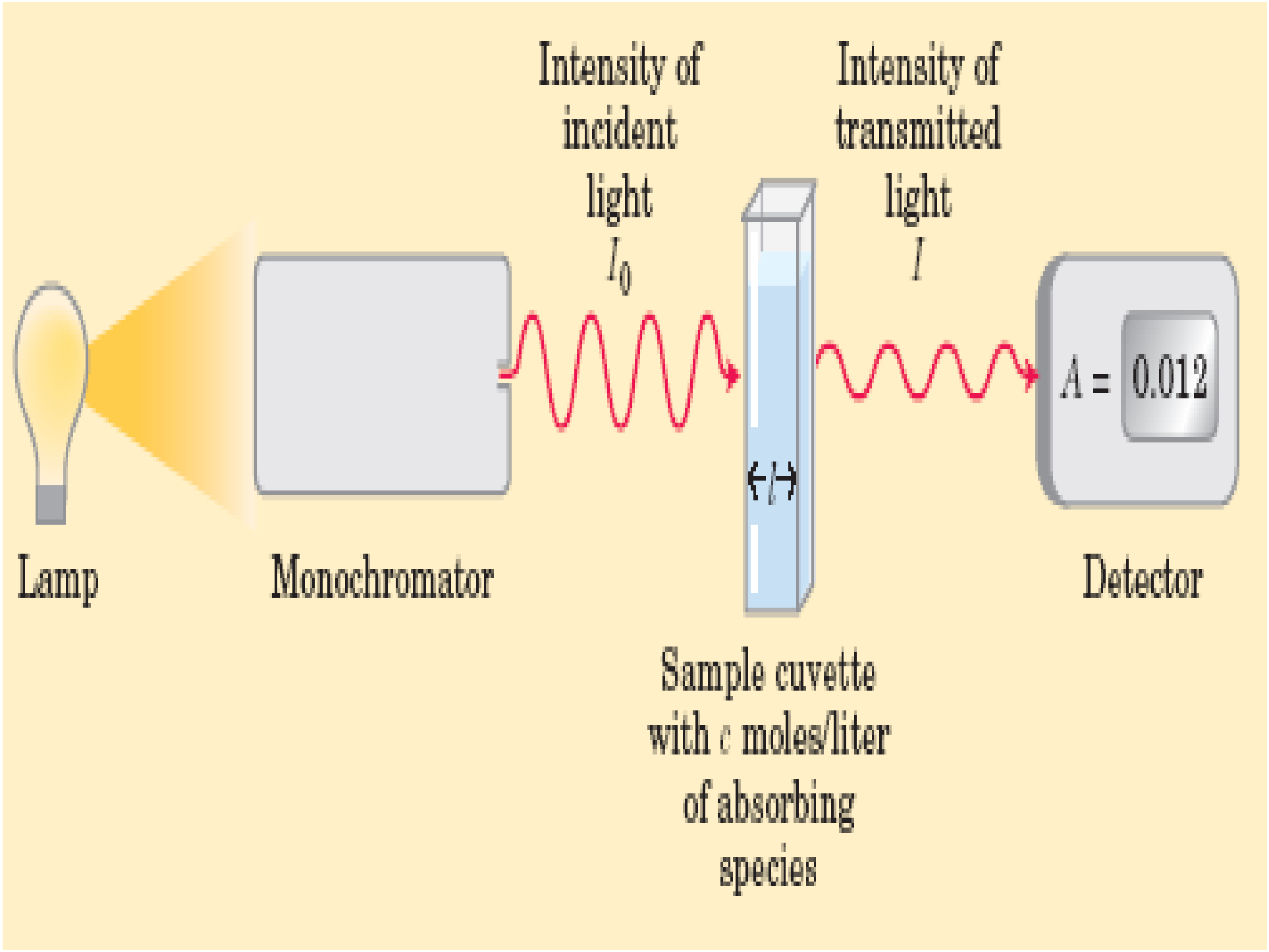
•Costly than others.

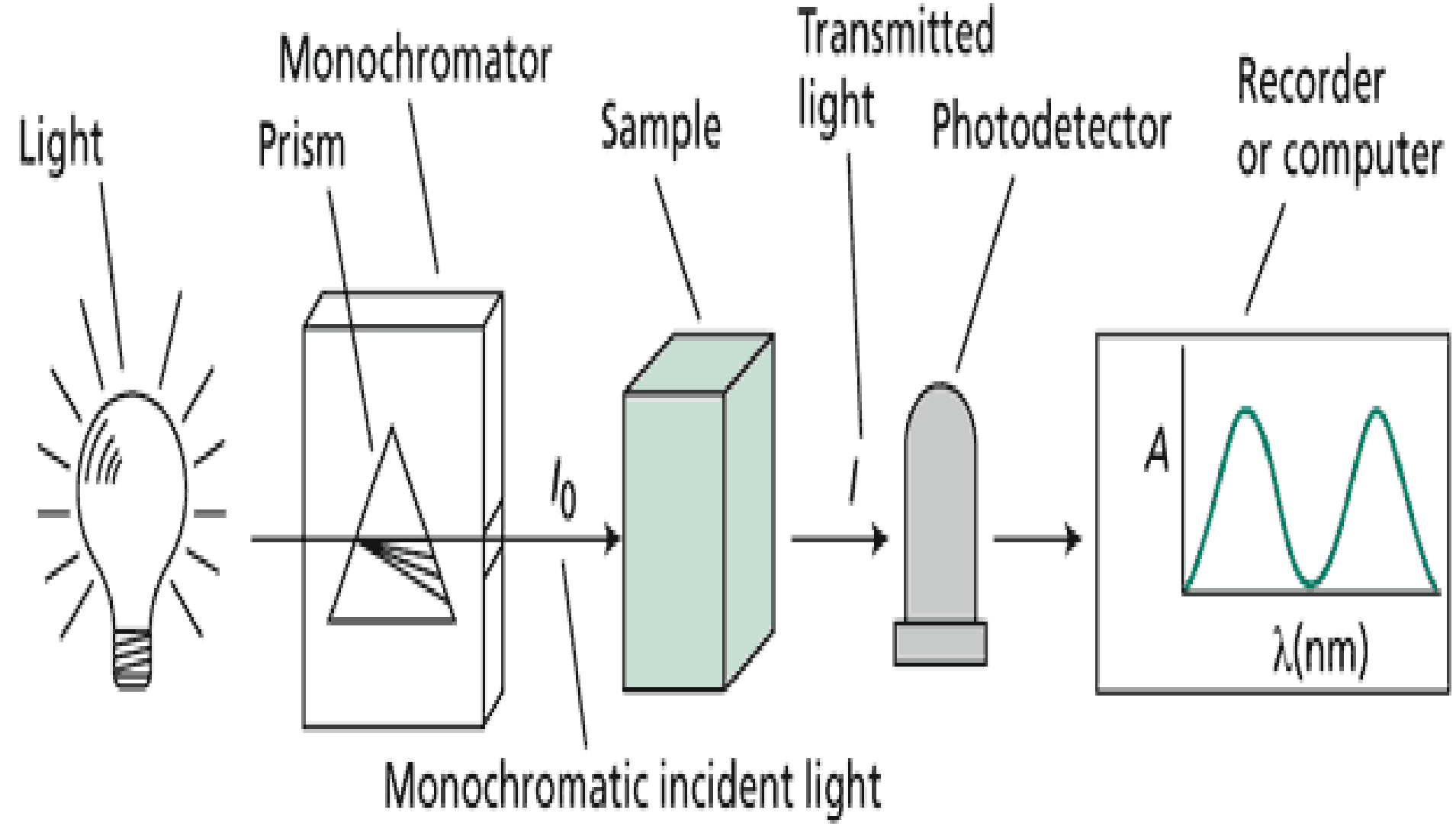
PHOTOCELL (PHOTODETECTOR)

- these are the devices to measure the intensity of light by converting light energy in to electric energy.
- They are made up of light sensitive material such as selenium.

GALVANOMETER

- Readout device.
- A galvanometer is used to detect and measure eletrical current produced by the photodetecter.
- It is calibrated to read directly either transmittance or absorbance or both.


Intensity of incident light I_0
Intensity of transmitted light I
$A = 0.012$
l
Lamp
Monochromator
Detector
Sample cuvette with c moles/liter of absorbing species


Light
Monochromator
Prism
Sample
Transmitted light
Photodetector
Recorder or computer
I_0
I
A
λ(nm)
Monochromatic incident light

ADVANTAGES OF COLORIMETER

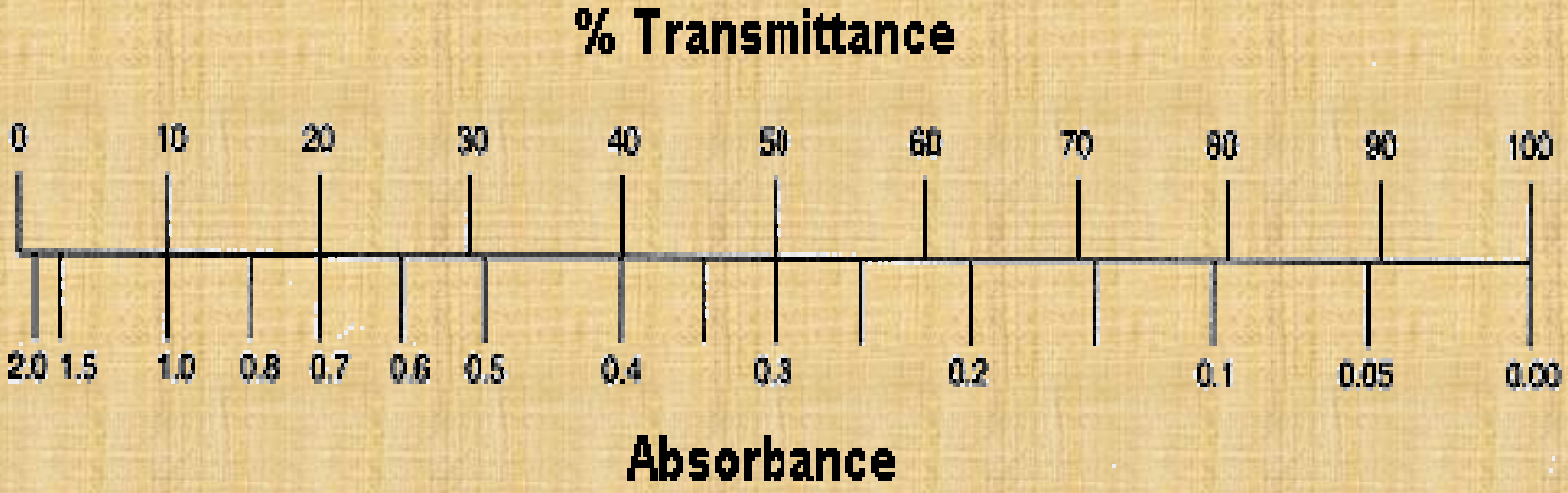
- The manual operation are limited.
- It is very easy to operate.
- For the photometric reading of unstable colored complexes, the single cell photometer can be very useful.

DISADVANTAGES OF COLORIMETER.

- Less sensitive.
- Limited range of filters available.
- If the light source is not stable ,there is a possibility of errors due to a change from the initial light intensity during a measurement.

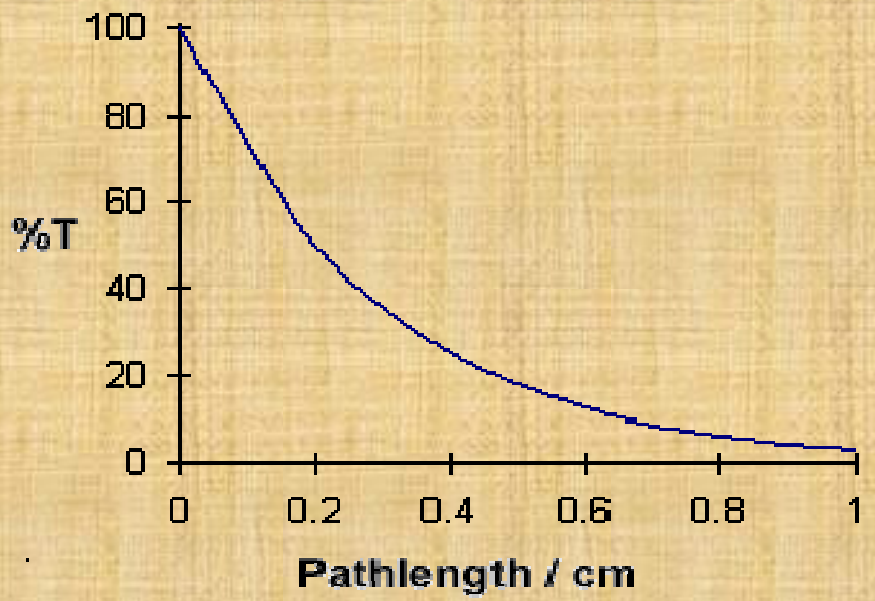
Equation, $A = 2 - \log_{10} \%T$.
The relationship between absorbance and transmittance is illustrated in the following diagram:

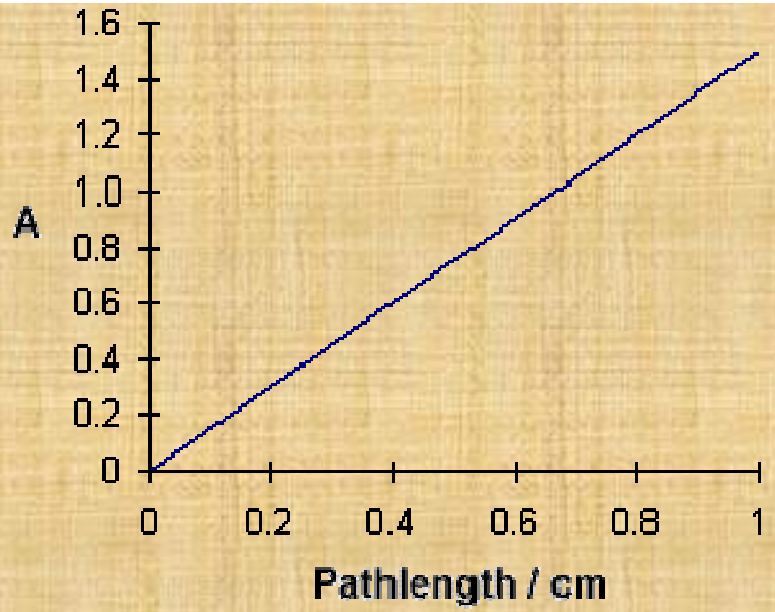
So, if all the light passes through a solution *without* any absorption, then absorbance is zero, and percent transmittance is 100%. If all the light is absorbed, then percent transmittance is zero, and absorption is infinite.



Where A is absorbance (no units, since $A = log10\ P0 / P$)
e is the molar absorbtivity with units of L mol-1 cm-1

b is the path length of the sample - that is, the path length of the cuvette in which the sample is contained. We will express this measurement in centimetres.
c is the concentration of the compound in solution, expressed in mol L-1
The reason why we prefer to express the law with this equation is because absorbance is directly proportional to the other parameters, as long as the law is obeyed. We are not going to deal with deviations from the law.





A= ebc

tells us that absorbance depends on the total quantity of the absorbing compound in the light path through the cuvette. If we plot absorbance against concentration, we get a straight line passing through the origin (0,0).