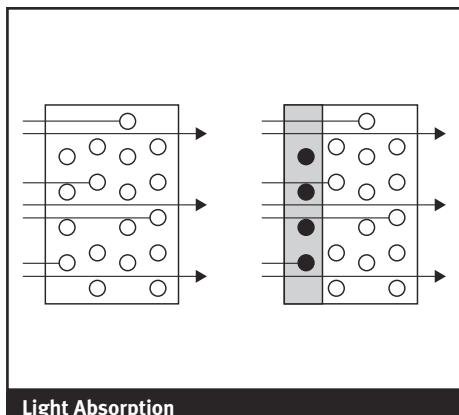
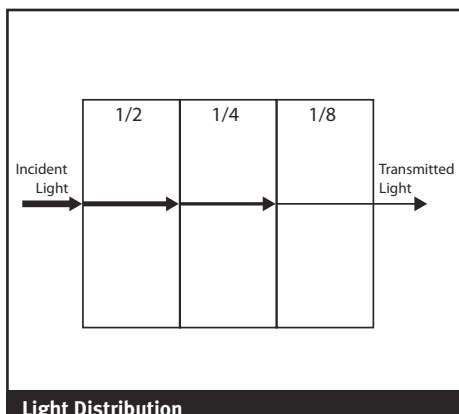


## Orion Colorimetry Theory



**Light Absorption**

If a sample contains a dilute solution of molecules that absorb light, some of the light will pass through, and some will be absorbed.



**Light Distribution**

Since the absorbing molecules are uniformly distributed throughout the solution, any given “slice” of the solution absorbs the same fraction of light passing through it. What might be expected is that if the path length doubles, there would be half as much light, but it doesn’t work that way, because some of the light has already been taken out.

In colorimetry, the transmission of light and its absorbance have very specific meanings.

These are:

$$\text{Transmittance (T)} = \frac{\text{Light transmitted (I)}}{\text{Incident light (I}_0\text{)}} \quad \text{Absorbance} = \text{Log (1/T)} = abc$$

where: “a” is a constant --the ability of a given molecule to absorb a particular wavelength of light  
 “b” is the path length--the longer the path, the less light gets through.  
 “c” is the concentration--the more molecules in the solution, the more light is absorbed.

To get a straight line calibration curve, absorbance vs. concentration needs to be plotted. The equation of colorimetry used for the calibration curve is Beer’s Law.

where: Beer’s Law is the Transmitted light = Initial light  $\times 10^{(-abc)}$

### Colorimeter Setup:

A colorimeter requires a light source, a filter, a sample with a fixed path length, and a detector. In Orion colorimeters, the light source uses Light Emitting Diodes (LED’s). The advantage of using LED’s is longer battery life and its temperature stability which does not shift wavelength with changes in temperature. The filter removes all light except the wavelengths used for the analysis. The detector determines how much light was transmitted through the sample for correlation to concentration.

### Factors Affecting Colorimetric Measurements:

Some factors affect colorimetric measurements, therefore choice of wavelength is important. To get the greatest sensitivity and selectivity, it is important to try to get as close as possible to an absorbance peak. (If LED’s are used as light sources, the exact wavelength is not always available). Sample blanks and zeros are also important. It is good practice to run a “zero” (untreated sample) to correct for stray light, sample color or turbidity, or absorption of the measured wavelength by some constituent of the sample, and to correct for internal reflection of light by container walls.

### Colorimetry Chemistry:

Most of the species in water do not have any color, meaning that the species do not absorb light in the visible region. To measure the absorbance of the colorless molecules, a reaction must be found which will produce a color that can be measured. Many approaches are available, and the most used are:

- React the species with a reagent to produce a new compound which has one or more chromophores
- Chelate the species to form a complex with a different color than either the species or the original chelant.
- Use a colored compound which is bleached by the species being analyzed.
- Form an intermediate compound that can be oxidized or reduced afterwards to give a colored compound

Developing a test includes finding the optimum pH for reaction and color development, “masking” of possible interferences, and determining optimum time for measurement. Orion tests are all based on widely-accepted, chemistries.

### What is Turbidity?

Turbidity is the interaction between light and suspended particles in water. It is a qualitative measurement because the reflection and scattering of light from particles depends on the nature of the particular particles. Particle size and shape affect the direction and intensity of the scattered light, as will its color, and how transparent or reflective it is. The scattering intensity and direction of scatter also changes with the wavelength of the incident light. In general, the greater the intensity of scattered light, the higher the turbidity, it is not possible to quantitatively estimate particle concentration unless the particles are uniform and reproducible.

Turbidity is an important water quality indicator for suspended solids such as silt, clay, algae, microorganisms, organic matter and other minute particles, and it can interfere with many chemical and biological tests. Turbidity is measured in units of NTU (Nephelometric Turbidity Units), or in units of FTU (Formazine Turbidity Units), depending on the calibration standard used.