Light and Atoms PhET

Go to http://phet.colorado.edu/en/simulation/beers-law-lab

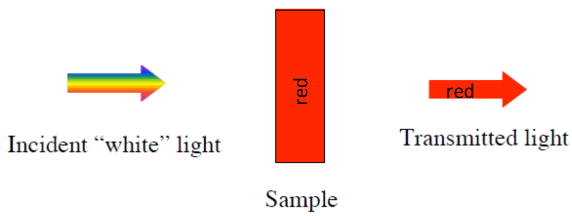
Open up the "Beer's Law Lab" simulation. Click on the Beer's Law Tab (

)on the top.

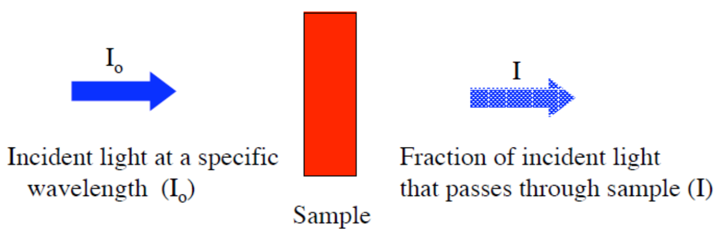
Answer these questions by the end of this activity:

1. Why are some solutions colored?
2. Also, how does the observed color intensity depend on solution concentration?
3. How can we use these two facts to determine solution concentration?

A little Background Information:



Sample looks red because only wavelengths corresponding to red pass through the sample and are detected by your eye. This implies that color is due to the absorption of certain wavelengths by the sample.



We can define the percent transmitted intensity(%T) as follows:

$$\%T = \frac{I}{I_o} \times 100\%$$

Procedure:

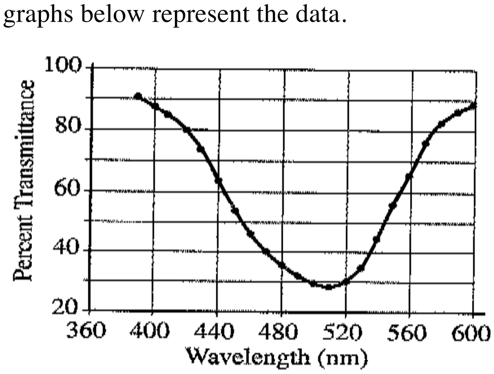
1. Use the Drink Mix solution until later on in the experiment. Make sure the detector is set to %Transmittance. Set the light source to variable light and experiment with the sample to see what wavelengths of light the sample absorbs and does not absorb. Record your observations for which wavelengths of light the sample does and does not absorb. Which wavelength do you think is optimal for observing this sample? Why?

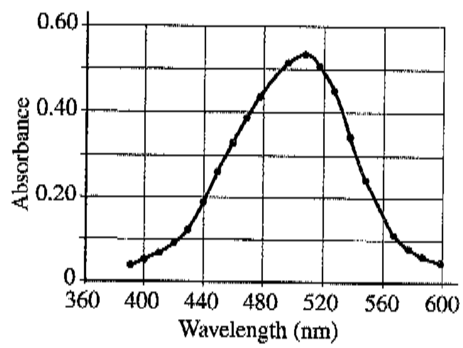
2. Put the light source on fixed. Now observe the color of the light. To determine the exact wavelength value you can switch to variable but not move the toggle switch. How does the fixed wavelength compare to what you thought would be the best wavelength?

3. What conclusions can you draw about the best wavelength for measuring a given sample with Beer Lambert's Law?

4. Use your conclusion above to answer the following question

The student takes the 0.10 M solution and determines the percent transmittance and the absorbance at various wavelengths. The two graphs below represent the data.





(a)Identify the optimum wavelength for the analysis. ___________

5. Switch the detector to absorbance. How do the values for absorbance compare to the transmittance values?

Absorbance is defined as $-\log(I/I_0)$.

6. Leaving the light source at fixed wavelength, investigate how the transmittance changes when you increase the concentration. How does transmittance change with a change in concentration?

7. Explain in terms of molecules at the molecular level why you see this trend in transmittance with a change in concentration.

8. Record the transmittance and absorbance data for one substance at varying concentrations below.

Data for __________________

Concentration	**Transmittance**	**Absorbance**

9. Make a graph of absorbance vs concentration. (Absorbance should be on the y-axis and concentration should be on the x-axis)

10. Make a graph of transmittance vs concentration. (transmittance should be on the y-axis and concentration should be on the x-axis)

11. Compare the two graphs. Which graph has the most linear relationship?

12. Choose a set concentration and fixed wavelength. Use the ruler at the bottom to measure the width of the sample. Use the yellow arrow to change the width of the sample. Record in the data table below how the absorbance changes with the width of the sample.

Data for _________________ at ___________ μM

Absorbance	**Width of sample**

13. Make a graph of absorbance vs width of the sample.

14. Is this graph linear?

15. Leave the concentration, light source, and width of the sample at constant values. Move the light sensor detector closer to and farther from the sample. Does the transmittance and absorbance values change as you move the detector? Explain your data and observations in terms of the molecular level.

16. The relationship between concentration, absorbance, and path length is described by Beer's Law which is

$$A = \varepsilon bc,$$

where A = absorbance, ε = the molar extinction coefficient ($M^{-1}cm^{-1}$), b = path length (in cm), and c = concentration in Molarity.

Pick two different solutions. Collect data for the two solutions in the data table below. Then using Beer's Law, determine the molar extinction coefficient of each solution.

Solution		
Concentration in μM		
Concentration in M		
Absorbance		
Path Length in cm		
Molar Extinction Coefficient ($M^{-1}cm^{-1}$)		

Analysis:

1. Why are some solutions colored?

2. Also, how does the observed color intensity depend on solution concentration?

3. How can we use these two facts to determine solution concentration?