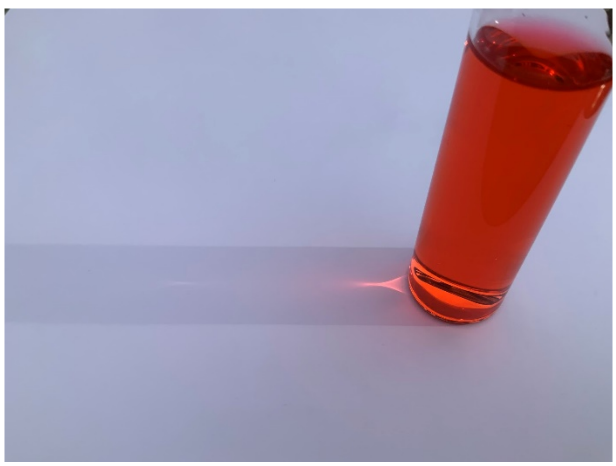
<u>**Beer's Law Activity**</u>
Spectrophotometry and Solution Concentration

A solution that appears colored to the human eye has the appearance it does because it absorbs visible light. Consider a fruit-punch flavored sports drink that is red. If you are exercising outside on a sunny day and hold a bottle of this drink up to the light, you will see red light coming through the drink.



The sun emits a visible light spectrum consisting of red, orange, yellow, green, blue, indigo, and violet light. We would say that the red light makes it through the sports drink very well-- almost all of the red light is transmitted. On the other hand, green light does NOT make it through the sports drink very well-- most of this light is absorbed. In fact, that's precisely why we DON'T see much green appearance when we hold up the drink to the sun.

We can use this property of absorbance to make determinations about the concentration of a solution. Beer's Law is the mathematical relationship, shown below:

$$\text{Abs} = \varepsilon c l$$

In this equation, the variable abs represents absorbance, which is a way of measuring how much light is making it through the sample. The variable ε represents the molar absorptivity, or a measure of how well a given compound absorbs light. The variable l represents the path length the light has to travel to get all the way through the sample.

Beer's Law is going to be most useful to us because it provides a mathematical model that indicates a direct proportion relationship between the absorbance of a sample and its concentration. Notice from the equation above that if the concentration of a sample doubles, the absorbance will also double. To return to our sports drink analogy, a more concentrated solution of the drink will absorb more light.

We will plan to take advantage of this idea by using a spectrometer to measure absorbances for several different solutions whose concentrations we know. The data will fall on a line because of the linear, direct proportional relationship between the variables of absorbance and concentration. We call such a line a "calibration curve"--even though the data will most likely fall on a straight line. (Scientists use the word "curve" to refer to ANY mathematical equation… not just functions that appear curvy!) Then, we should be able to take a solution whose concentration we don't know, get its absorbance, and calculate its concentration from the equation of the line for our calibration curve.

At this point, you should watch the movie that comes along with this activity if you have not yet done so. Then, proceed to answer the post-lab questions.

Beer's Law Activity Post-Lab Questions Name______________________________

1. Refer to the best-fit line equation that the MicroLab software generated for the known samples ("standards") in the movie. Record the equation here.

2. Refer to the absorbance of the unknown that was measured near the end of the experiment. Use the best-fit line equation to calculate the concentration of the unknown. Show your math here. (Recall that our units of concentration were being expressed as mL of stock solution per vial.) You can check your answer against the concentration calculated by the software in the movie.

3. Suppose a student's unknown was analyzed and found to have an absorbance of 0.105. What would be the concentration of this unknown? Show your calculation.

4. Suppose another sample was analyzed and found to have an absorbance of 0.45. As was explained in the movie, graphs of absorbance versus concentration can NOT be assumed to be linear for infinitely high concentrations. Suggest a procedure that could be performed in order to determine the concentration of this sample. Hint: you might do a little review/further study on the equation $C_1V_1 = C_2V_2$.

5. When you watched the movie, the data that Dr. Zuidema gathered did not fall along a perfect line. Suggest at least two possible sources of error in the experimental procedure that could be adjusted in a future trial in order to get better data. (Be as specific as possible, and avoid vague terms such as "human error.")