1) Log(x) and 10^x are inverse functions.

Use them to convert between %Transmission and Absorbance.

Note that if %T = 99 then T = 0.99.

- %T = 99 %, A = -log(0.99) = 4.3 x 10^{-3}
- %T = 90 %, A = -log(0.90) = 4.6 x 10^{-2}
- %T = 55 %, A = -log(0.55) = 2.6 x 10^{-1}
- %T = 9.0 %, A = -log(0.09) = 1.05
- %T = 0.9 %, A = -log(0.009) = 2.046

2) If the absorbance increases by a factor of 1 A.U. or absorbance unit how does %Transmission decrease?

Looking at the answers to the second part of question 1 it can be seen that when the absorbance increases by plus 1 absorbance unit the %Transmission decreases by a factor of 10. Example: A goes from 1 to 2 while %T goes from 10% to 1%. When A decreases by minus 1 absorbance unit %T increases by a factor of ten times. The relationship of a change of 1 unit in a variable resulting in a change of a factor of 10, also known as an order of magnitude, is a property of logarithmic functions.

3) If a 0.5 ml test solution that is 0.35 M in glucose is mixed with 3.0 ml of the reagents needed to produce a color change, what is the glucose concentration in the final colored solution?

If it was determined that a 3.5 ml final colored solution had a glucose concentration of 0.21 M what was the glucose concentration in the initial 0.5 ml sample volume?

Use

\[ V_{\text{old}}M_{\text{old}} = V_{\text{new}}M_{\text{new}} \]

\[ V_{\text{old}} = 0.5 \text{ ml}, \ M_{\text{old}} = 0.35 \text{ M}, \ V_{\text{new}} = V_{\text{old}} + 3.0 \text{ ml} = 3.5 \text{ ml} \]

\[ M_{\text{new}} = V_{\text{old}}M_{\text{old}} / V_{\text{new}} = 0.5 \text{ ml} * 0.35 \text{ M} / 3.5 \text{ ml} = 0.05 \text{ M} \]

\[ V_{\text{new}} = 3.5 \text{ ml}, \ M_{\text{new}} = 0.21 \text{ M}, \ V_{\text{old}} = V_{\text{new}} - 3.0 \text{ ml} = 0.5 \text{ ml} \]

\[ M_{\text{old}} = V_{\text{new}}M_{\text{new}} / V_{\text{old}} = 3.5 \text{ ml} * 0.21 \text{ M} / 0.5 \text{ ml} = 1.47 \text{ M} \]

4) Given the following absorbance data collected with using a cell with a 1 cm path length for a chromophore that absorbs light at 750 nm.

<table>
<thead>
<tr>
<th>Concentration (M)</th>
<th>Absorbance (A.U.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>0.001</td>
<td>0.021</td>
</tr>
<tr>
<td>0.003</td>
<td>0.074</td>
</tr>
<tr>
<td>0.006</td>
<td>0.155</td>
</tr>
<tr>
<td>0.012</td>
<td>0.227</td>
</tr>
<tr>
<td>0.024</td>
<td>0.411</td>
</tr>
<tr>
<td>0.050</td>
<td>1.074</td>
</tr>
</tbody>
</table>

Determine the value of the extinction coefficient using a Beer’s Law plot.

What would be the absorbance of a solution that has a concentration of 0.015 M? of 0.037 M?

What is the concentration of a solution that has an absorbance of 0.47 A.U. in a 1 cm cell?

A Beers Law plot (Absorbance vs. Concentration) was made using the given data.
The slope of the trendline gives the value of the extinction coefficient ($\varepsilon$),

$$\varepsilon = 20.803 \text{ M}^{-1}\text{cm}^{-1}.$$ 

The equation for the trendline can be used to find the absorbance of a solution if the concentration is known.

- $X$ is the concentration and $Y$ is the absorbance.
- Absorbance = $20.803 \times 0.015 - 0.005 = 0.307$ A.U.
- Absorbance = $20.803 \times 0.037 - 0.005 = 0.765$ A.U.

The equation for the trendline can be used to find the concentration of a solution if the absorbance is known.

- Concentration = $(0.47 + 0.005)/20.803 = 0.023$ M

The last three answers can also be found graphically.

5) You need to make a 1 $\mu$M (micromolar) solution from a 1.0 M stock solution.

If you start with 1.0 ml of the stock solution:

a) How much solvent is needed to make a solution with the needed concentration in one dilution? b) How much solvent will be needed to make a solution with the needed concentration if a series of three 1:100 (old volume: new volume) dilutions are done? From each dilution 1.0 mL of the new solutions will be diluted until the final concentration is reached. What are the concentrations of the intermediate solutions?

The serial dilution will use less material and create less waste.

One Dilution: Using 1 ml of the stock solution: $1 \text{ml} \times 1 \text{M} = 1 \times 10^{-6} \text{M} \times X \text{ml}$.

$$X = 1 \times 10^5 \text{ ml or 1000 L} \quad \text{That is a lot of solvent.}$$

Serial Dilution:

Step 1: Take 1 ml of the stock solution. Add 99 ml of solvent to get a new volume of 100 ml. The new concentration is now 1/10 of the original concentration.

Step 2: Take 1 ml of the new solution. Add 99 ml of solvent to get a newer volume of 10 ml. The concentration is now 1/10,000 (= 1/100*1/100) of the original concentration.

Step 3: Take 1 ml of the newer solution. Add 99 ml of solvent to get a newest volume of 10 ml. The concentration is now 1/1,000,000 (= 1/100*1/100*1/100) of the original concentration or 1 $\mu$M.

Only 297 ml of solvent was used to achieve the needed dilution. This saved 999.703 L of solvent.