# Tips for Teachers — Beer's Law Lab

## Concentration Screen

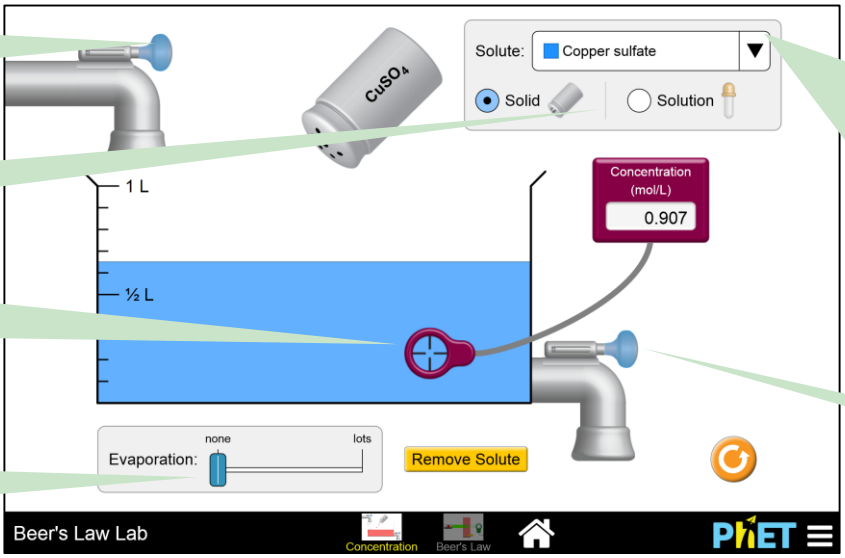
In this screen students explore how the concentration of a solution is changed by varying the amount of solute, solvent, or total amount of solution.

**ADD** water to beaker.

**ADD** solute as a solid or liquid.

**MEASURE** solution concentration.

**REMOVE** water from beaker.




**CHOOSE** solute.

- Drink mix
- Cobalt (II) nitrate
- Cobalt chloride
- Potassium dichromate
- Potassium chromate
- Nickel (II) chloride
- Copper sulfate
- Potassium permanganate

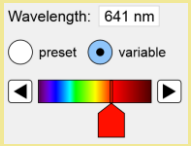
**DRAIN** solution.

## Beer's Law Screen

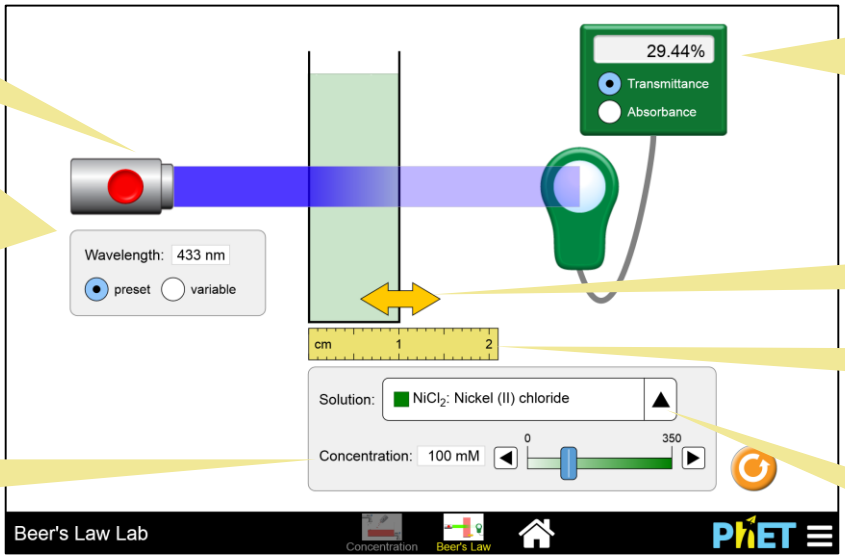
Students investigate how the intensity of light absorbed or transmitted by a colored solution changes with solution type, solution concentration, container width (pathlength), or light source.

**TURN** on/off light source.

**SELECT** wavelength of light source.




**VARY** solution concentration.




**MEASURE** transmittance or absorbance of light.

**CHANGE** size of container.

**MEASURE** pathlength.

**SELECT** solution.

Hanson, October 2015

## Insights into Student Use

- The detector on the transmittance/absorbance meter must capture the full beam of light to show a value for transmittance or absorbance.
- Students who had not been introduced to Beer's Law were able to make accurate qualitative conclusions about the effects of pathlength, concentration, and wavelength on light absorption.
- Yellow and blue solutions may be easier for some colorblind students, but different types of colorblindness may make different solutions harder to see for different students.

## Model Simplifications

- The maximum amount of solute that can be added is 6 moles. The maximum volume of the beaker is 1 L.
- Concentration is calculated as solute amount divided by *water* volume. The volume of dissolved solute has only a small effect on volume, and different volume changes for each solute could be confusing to students.
- The values used to calculate the solubility for each solute were taken from the CRC Handbook of Chemistry and Physics 91st edition (http://www.hbcpnetbase.com). Drink mix was assumed to have the same solubility as sucrose.
- Color intensity of solution was optimized to highlight changes in concentration for the range allowed in each tab, but color intensity *is not the same* between the Concentration and Beer's Law screens. For example, the range for Drink mix is 0-5.960 M in the Concentration screen but 0-0.400 M in the Beer's Law screen.
- The values for molar absorptivity used in the sim were calculated from experimental data; replicating the experiment may produce slightly different values.

## Suggestions for Use

### Sample Challenge Prompts

- Describe the relationships between the amount of solute, volume of solution, solution color, and solution concentration.
- What happens to the concentration of a solution when the solution volume is decreased?
- Predict what happens to the absorbance of a solution as the concentration of the solution increases.
- Describe the relationship between the width of the solution container (pathlength) and absorbance of light.
- Explain the difference between transmittance and absorbance of light.
- How do you think the preset wavelength was chosen for a given solution? Is this the best wavelength to use for the solution? Why or why not?
- Describe the relationship between the color from the light source, the solution color, and the absorbance of the solution.
- Use Beer's law ($A = \varepsilon lC$) to determine the molar absorptivity ($\varepsilon$) for a given solution.

For more tips on using the Concentration screen, see our Concentration sim page.
See all activities for Beer's Law Lab here.
For more tips on using PhET sims with your students, see Tips for Using PhET.

Hanson, October 2015