

# "Concentration of liquid (Beer's Law)"

**Subject: Chemistry**

**Sensor: Colorimeter**

## Overview:

This procedure shows how the colorimeter can be used to measure the concentration of an unknown sample using Beer's Law. In low concentrated solutions the amount of light absorbed at a specific wavelength is directly proportional to the concentration of the solution, this is Beer's Law. At higher concentrations, the proportionality is lost.

This procedure will use a blue food dye to plot an Absorbance (Abs) against concentration (%) calibration graph and then use the graph to show how unknown concentrations can be found.

## Equipment required:

- LogIT DataLogger
- 1 Colorimeter
- 1 Pipette or Micro Burette
- 1 Cuvette
- Blue food colouring
- Distilled water
- Paper towels or tissue paper to dry the cuvette

## Hazards:

Goggles should be worn.  
Food colours can stain clothing so possible use of aprons or trays to prepare samples could be used.  
If using this procedure for obtaining concentrations of other chemicals such as Copper II Sulphate, always check your local regulations or the school advisory service such as CLEAPSS or SSERC for guidance on the use of any hazardous material or chemical.

## Setup of solutions and datalogger:

1. Make up a 100% solution of food colouring and distilled water. (We used 5 drops in 1 litre)
2. Make up a selection of concentrations. We used 20%, 40%, 60% and 80%

Hint: This can be done either in large beakers for the class to use or they can be made up by the pupils in the cuvettes. This is a good procedure for pupils to learn about accurate liquid measurement. Using 5 ml cuvettes, it is a good idea to use a total of 4 ml in the cuvette so as not to run the risk of the liquid sample spilling into the colorimeter.

The samples were then made up as follows:-

- 80% = 3.2 ml of 100% solution + 0.8 ml of distilled water
- 60% = 2.4 ml of 100% solution + 1.6 ml of distilled water
- 40% = 1.6 ml of 100% solution + 2.4 ml of distilled water
- 20% = 0.8 ml of 100% solution + 3.2 ml of distilled water

These are the 'known' concentrations. All five (4 above plus 100%) could be used for the calibration graph, you would then need to make up some 'unknown' samples for the pupils to test or you could use three for calibration and then 2 of the above samples for the pupils to try and obtain from their graphs. For this example we used all five for the calibration and then made up a 25% and then a 65% solution for the 'unknown'

3. Connect the colorimeter to a channel on the datalogger.
4. Start the datalogging software.

# "Concentration of liquid (Beer's Law)" (continued)

## Setup of software:

This setup uses LogIT Lab as an example, Insight setup is similar.

1. From the 'Select New Activity' screen, select 'Set Up'
2. Select 'Snapshot' from the setup wizard and click 'Next'
3. Click the down arrow next to the Colorimeter 0 to 110 %T scale and select 'Colorimeter, 0.000 to 1.300 Abs' as shown in fig 1 and then click 'next'.

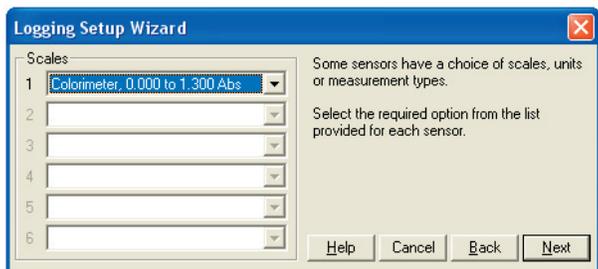


fig 1.



fig 2.

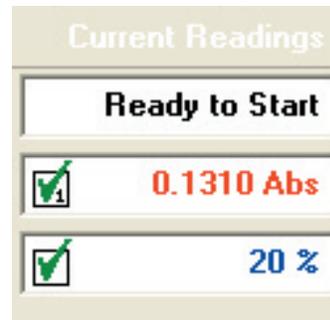


fig 3.

4. Click 'Finish'.
5. Now you need to set up the concentration on the x-axis.
6. Place the cursor into the Abs readings box on the right of the LogIT Lab screen and right click. A menu should appear as shown in fig 2.
7. Select 'Add Field..' and enter 'Concentration' in the Name field, '%' in the Units field and then the concentration value of your first known sample eg. if measuring the 20% sample, enter 20 in the Value field. Then click 'OK' and then click on the small white box to the left of the 20%. (fig 3.)
8. Now, right click on the X axis and select ' X Axis Scale' from the list and select 'Concentration'.
9. Press 'F4' to select lines to be plotted between the points.
10. The software is ready for use.

## Calibration:

To calibrate the colorimeter, select the RED light source and place 4 ml of 100% solution into a cuvette and into the colorimeter. Adjust the calibration dial until you obtain 0.80 Abs.

## Method:

1. Place the first sample into the colorimeter. eg. 20%
2. Right click on the concentration field shown in fig 3 and select 'Edit details' from the list (fig2) which should appear. Enter the concentration of the sample and then click 'OK'
3. Click on the camera icon to store the reading.
4. Place the second sample into the colorimeter and then follow steps 2 & 3 to select the new concentration and take a reading.
5. When you have finished the known samples you will have a calibration graph.

The unknown samples can now be measured and read off the calibration graph. This can be done within the software or the graph can be printed and used in a group.

## Notes on procedure:

This procedure can liberate some very good results so long as pupils perform basic laboratory practise. Cuvettes should be washed out with distilled water between readings. Measurements should be accurate. A burette may be used although pipettes might be more common and easier to use.

This procedure can be used with Iron tablets, Copper Sulphate etc. You could also use molarity of a solution as opposed to the percentage concentration.

