

## NEULOG COLORIMETER LOGGER SENSOR GUIDE



### NeuLog colorimeter logger sensor NUL-219

The colorimeter sensor can be used for any science experiment where liquid samples of different colors and concentrations are utilized such as in the fields of Chemistry, Biology, Pharmacology, Biochemistry, Environmental Science, Physics, or even just to study the behavior of light waves.

Colorimeters are used to determine absorbance or transmittance of given wavelengths (generally red, green, and blue) in a liquid solution. Absorbance and transmittance are directly related to the concentration of known solutes in the solution which is calculated using the Beer-Lambert law. One parameter can be calculated from the other.

The sensor comes pre-calibrated so you can start experimentation right out of the box using this guide.

Hundreds of possible experiments that can be performed with the NUL-219 sensor are: Analyzing chemical reactions, studying Beer's Law, water quality testing, monitoring of ecological systems, study of photosynthesis, studying light waves. The colorimeter could take the place of a spectrophotometer in many experiments.

The NeuLog colorimeter sensor's measurement units are:

- % Transmittance: The amount of light that passes through a sample
- Absorbance: The amount of light which is absorbed by a sample

### Cuvette usage and handling:

It is important to maintain a standard for cuvette usage as their quality will directly impact the results of your experiments. If the cuvette has fingerprints, smudges, or cracks the sensor will detect them and give off an improper colorimeter reading. Smudges left from handling can easily be wiped off with tissue paper.

#### Proper usage:

1. Carefully remove the cuvettes from their packaging.
2. Load your liquid sample into the cuvette before placing it into the sensor to prevent spilling and damaging the sensor.

3. Plug the cap into the cuvette and gently invert a few times. Shaking will create air bubbles which will be detected by the sensor and give an incorrect reading.
4. Before placing the cuvette in the sensor; hold it as far towards the top as you can and wipe off the bottom with a tissue. Do not touch the bottom of the cuvette again as this will leave a residue which could affect the results of the experiment.
5. If you have a cuvette with four clear sides, place it in the colorimeter sensor. If you have a cuvette with two opaque sides:
  - a. Determine which sides of the cuvette are clear and which sides have an opaque finish.
  - b. The clear opposing sides must be positioned facing the front and back of the sensor (they won't fit the other way) while the glossy sides face either side.
  - c. If the cuvette does not fit with a gentle push, rotate 90° in either direction and try again.
6. After experimentation, empty your samples, gently rinse out the cuvettes with distilled water and let them air-dry.

### Selecting a wavelength:

Selecting the correct wavelength is important to get the best data and can easily be determined using one of two different methods. There is no incorrect wavelength, just some which are more informative than others. Lab experiments often come with a predetermined wavelength to use. If your experiment does not, follow one of these methods for best results:

- Knowing that the color we see solutions is based on the color reflected from them (and not absorbed): Choose a color you know will be absorbed. For example, if the solution is red try the blue LED option.
- Once the sensor is connected and the NeuLog software is open (follow one of the guides below for more instruction) click the "Module setup" button in the module box and try the different LED color options to determine which has the highest absorbance (it will appear in real time on the sensor's module box). Select the color which has the highest absorbance reading.

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### Quick start procedure:

#### PC or Mac Computer

##### Materials needed:

- NUL-219 Colorimeter Sensor
- Cuvettes + Cuvette Lids
- USB-200 USB Module
- USB to mini USB cable (included with the USB-200 module)

Your colorimeter sensor needs to be connected to a USB-200 module. The USB-200 module then connects to a computer via a USB to mini-USB cable. Please note that you cannot plug the colorimeter sensor directly into the computer.

The browser based application can be downloaded for free at [www.NeuLog.com](http://www.NeuLog.com) as well as a full application user guide. Choose "Downloads" on the main menu and then choose "Software and Application".

##### Procedure:

1. Install the NeuLog application.
2. Connect the USB-200 module to the PC or Mac.
3. Connect the colorimeter sensor to the USB-200 module (they directly plug together). Please note that no calibration is required for this sensor.
4. Open the NeuLog application by clicking on the shortcut on the screen.
5. Once a colorimeter sensor module box appears on the left side of the screen the probe has been automatically identified and you can begin experimentation.
6. If the colorimeter sensor is not automatically identified then click the "Search for sensors" icon to find the sensor.
7. Select the "On-line experiment" icon; this will open a graph below.
8. Click on the "Module setup" button located in the colorimeter sensor module box to change the sensor's settings if need be.
9. Click on the "Experiment setup" icon to change the experiment settings if need be (experiment duration for example).
10. The colorimeter sensor will give a live reading in the module box to the left of the screen while plugged in.
11. To run an experiment and collect data click the "Run experiment" icon.
12. To end data collection early, click the "Stop experiment" icon.

#### Tablet, smart phone device

##### Materials needed:

- NUL-219 Colorimeter Sensor
- Cuvettes + Cuvette Lids
- WIFI-201 WIFI Module
- BAT-200 Battery Module

Your colorimeter sensor needs to be connected to a WIFI-201 module. The WIFI-201 module will create a closed NeuLog WiFi network which will stream the NeuLog data to a device of your choosing. Once your device is wirelessly connected to the NeuLog network, you can run experiments and collect data through a browser of your choosing.

##### Procedure:

1. Connect the colorimeter sensor directly to the left side of a WIFI-201 module (no wires required).
2. Connect a BAT-200 module to the right side of the WIFI-201 module.
3. Although not required, we recommend plugging the BAT-200 to an outlet using a USB to mini USB charger (such as a typical cell phone charger). The WIFI-201 module will run for 60-90 minutes (depending on the sensor) without being plugged in.
4. The WIFI-201 can be powered directly using a mini to USB cord and plugging it into your computer or a wall charger. Please note this function is only available on WIFI-201 modules with the USB icon on the cover.
5. For further WIFI-201 instructions or the WIFI-201 quick start guide please visit: [www.NeuLog.com](http://www.NeuLog.com); Choose "Products" on the main menu, then choose "WiFi Communication module".
6. The WIFI-201 indicator lights will flash; take no action until the LED to the far left turns blue; this can take up to one minute.
7. Take your tablet or smart phone, go to the WiFi settings and select the NeuLog network (NeuLog0184 for example) which matches the ID found on the back of the WIFI-201 module (0184 for example).
8. Give your device about 20 seconds to connect to the WIFI-201.
9. Once the device is connected, go to your browser and type the website [wifi201.com](http://wifi201.com) into the URL bar, then wait for 30-60 seconds.
10. You will see a "Control mode" icon in the application, click on it.
11. The application will then load a new screen and begin to auto detect the sensor(s); this can take a minute. (You can stop the search when the sensor is found.)

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12. If the application does not auto detect the sensor(s), select "Search for sensors".
13. Once the sensor is found you will see a module box on the left side of the screen for the colorimeter sensor. In this box, real time data will be displayed.
14. Click on the "Module setup" button located in the colorimeter sensor module box to change the colorimeter probe settings if need be.
15. Click on the "Experiment setup" icon to change the experiment settings if need be (Experiment duration for example).
16. To run an experiment and collect data, click the "On-Line" experiment icon, then click the "Run experiment" icon.
17. If you have a newer generation WIFI-201 module (with the USB icon on the cover) this can be used as a USB-200, meaning you can tether the probes directly to the computer using the WIFI-201. To engage operation in this fashion, press 3 times on the panel button. Repeating this operation will return the module to WiFi mode.

### Operation with NeuLog Graphic Display Module (viewer)

#### Materials needed:

- NUL-219 Colorimeter Sensor
- Cuvettes + Cuvette Lids
- VIEW-101 Graphic Display Module
- BAT-200 Battery Module

#### Procedure:

1. Connect the colorimeter sensor to the left side of the viewer.
2. Connect the BAT-200 module to the right side of the viewer.
3. The VIEW-101 will auto detect the sensor and you will see it appear on the left side of the screen.
4. Once the sensor appears it will be monitoring data in real time.
5. To run an experiment and collect data press the run icon (little green person).

### Off-line experiments

(Off-line experiments are when you do not have a sensor connected directly to a computer, tablet, smartphone, or NeuLog viewer).

#### Materials needed:

- NUL-219 Colorimeter Sensor
- Cuvettes + Cuvette Lids
- BAT-200 Battery Module

#### Materials needed to configure your offline experiment:

- USB-200 Module, WIFI-201 module or VIEW-101 Module
- USB to mini USB cable (included with the USB-200 module)

#### Procedure:

1. To determine the experiment settings, first connect to your chosen device (PC, Mac, tablet, smart device) and click on the "Off-line experiment" icon after the sensor search has ended. (For more information on how to change the experiment settings, view the quick start procedure section for your chosen device in this document.)
2. Connect the colorimeter sensor directly to the left side of a charged BAT-200 module.
3. When ready to collect data press the "Start/Stop" button on the colorimeter sensor, a red light will turn on for the duration of the experiment.
4. After the experiment has concluded (the "Start/Stop" button is pressed again or the data collection period ends) connect the sensor to your chosen device (you can find full instructions in each device's quick start procedure section).
5. Open NeuLog application.
6. Click the "Off-line experiment" icon.
7. Click the "Load data from sensors" icon.
8. Select which experimental data to upload (5 experimental runs can be stored at one time on the NUL-219 colorimeter sensor).

#### Restoring sensor's factory default settings:

#### Procedure:

1. Connect the USB-200 to a PC, Mac, tablet, or smart device.
2. Connect the colorimeter sensor to a USB-200 module (they directly plug together).
3. Open the NeuLog application.
4. Click the "Tools" icon.
5. Click the "Restore sensor's factory defaults" on the menu.

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### Included with the sensor:

- Three plastic cuvettes with three lids
- NeuLog NUL-219 Colorimeter Sensor Guide (This Document)

Sensor's specifications		
	Transmittance	Absorbance
Range and operation modes	0-100%	0-4
	Red, green, blue, and orange	Red, green, blue, and orange
ADC resolution	14 bit	
Resolution	0.02%T	0.01 abs.
Max sample rate (S/sec)	100	

**Experiment Duration:** 1 second to 31 days.

### Sensor's features:

- Fully digital data
- Rugged plastic ergonomic case
- Push button switch for Start/Stop experiments in off line mode
- Red, green, blue and orange LEDs for four different wavelength tests.
- Testing in both transmittance and absorbance
- Internal photodiode for detecting light
- 

**Note:** NeuLog products are intended for educational use.

### Videos and experiment examples:

- Videos, literature and other probes can be found at [www.NeuLog.com](http://www.NeuLog.com).
- In order to access the colorimeter sensor's page, choose "Products" on the main menu and then "Colorimeter logger sensor".
- In order to find the science experiments, choose "Experiments" on the main menu of the NeuLog website, then choose "Physics", "Chemistry", "Biology" or "Environmental Science".
- Chemistry Experiments:
  - Beer-Lambert law (C-28)
  - Color Absorption (C-31)

### Technical background:

The philosophy behind NeuLog's plug and play technology is based on each sensor's ability to store its own data due to an internal flash memory chip and micro-controller in each plastic NeuLog body. This technology allows the sensor to collect and then store the digital data in the correct scientific units ( $^{\circ}\text{C}$ ,  $^{\circ}\text{F}$ , Lux, %, ppm, for example).

The sensor is pre-calibrated at the factory. The built-in software in the logger can be upgraded for free at any time using the provided firmware update.

Inside the sensor's plastic body there are four LED lights (red, green, blue and orange) to test various wavelengths.

Light is transmitted from four different colored LEDs inside the sensor's body, one color at a time, passed through the cuvette containing a solution and then detected at the other end to determine the absorbance or transmittance of light at a specific wavelength.

The sensor works off of Beer's Law which is explained in the section "Beer's Law" below.

The four wavelengths emitted are:

- Red: 634 - 662 nm
- Blue: 452 - 476 nm
- Green: 500 - 530 nm
- Orange: 595 - 625 nm

### Beer's Law:

Beer's Law is an extremely useful concept for solution concentration testing in the fields of Chemistry and Biology.

Standard curves are created by using solutions of known concentrations which are analyzed in a colorimeter to determine the absorbance and then plot a graph. The absorption for unknown samples can easily be tested and plotted on the standard curve to determine their concentration.

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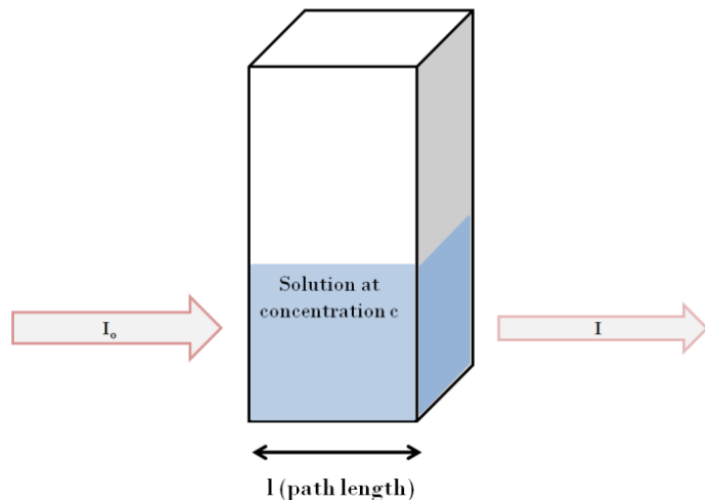
The law states that there is a logarithmic dependence between the transmission  $T$  of light through a substance, the product of the absorption coefficient of the substance  $\alpha$ , and the distance the light travels through the material  $l$ .

For liquids, these relations are usually written as:

$$T = I/I_0 = 10^{-\alpha l}$$

where  $I_0$  and  $I$  are the intensity of the incident light and the transmitted light, respectively.

The transmission (or transmittance) is expressed in terms of absorbance which, for liquids, is defined as



$$A = -\log_{10}(I/I_0) = -\log_{10}(T)$$

This implies that the absorbance becomes linear with the concentration (or number density of absorbers) according to  $A=\alpha l$

### Maintenance and storage:

- Never submerge the NeuLog plastic body in any liquid.
- Never place anything in the colorimeter sensor's opening on the faceplate except the approved cuvettes.
- Do not allow liquid into the NeuLog plastic body.
- After using the probe wipe off all excess material, liquid or residue from the colorimeter probe.
- Store in a box at room temperature out of direct sunlight.
- The cuvette handling and storage guide can be found at the beginning of this document.

### Warranty:

We promise to deliver our sensor free of defects in materials and workmanship. The warranty is for a period of 3 years from the date of purchase and does not cover damage of the product caused by improper use, abuse, or incorrect storage. Sensors with a shelf life such as ion selective probes have a warranty of 1 year. Should you need to act upon the warranty, please contact your distributor. Your sensor will be repaired or replaced.

Thank you for using NeuLog!



Flexible, simple, fast, forward thinking.

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