Experiment C-31
Color Absorption

Objectives

- To understand the concepts of light waves and color.
- To investigate how red, green and blue liquids absorb light of different wavelengths.
- To learn about colorimeter applications.

Modules and Sensors

- PC + NeuLog application
- USB-200 module
- NUL-219 Colorimeter logger sensor

Equipment and Accessories

▪ 50 ml beaker	3
▪ Plastic cuvette (included with the sensor)	3

- The items above (except for the cuvette) are included in the NeuLog Utility accessories, UTL-KIT.

Materials

▪ 20 ml of red food coloring (1:40 dilution)
▪ 20 ml of green food coloring (1:40 dilution)
▪ 20 ml of blue food coloring (1:40 dilution)

Introduction

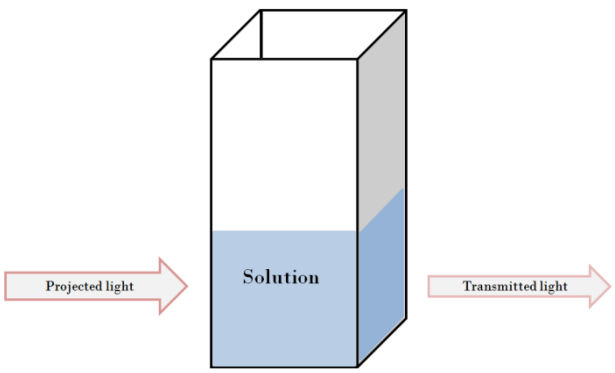
In order to understand color concepts, it is first necessary to understand light concepts. Visible light waves are seen by the human eye as different colors and they are characterized by their wavelength, which is the distance between any two corresponding points on successive waves. The length of the wave determines the amount of energy it has; the shorter the wavelength, the higher the energy.

Color may be also defined in more subjective terms, as something perceived by an individual. When light is reflected from an object, cones and rods in the retina of the eye respond to the light and the brain interprets the information received as color.

Light can be directly absorbed by an object, reflected at the surface or transmitted through it. The electromagnetic spectrum which is visible to us is in the range of 400-700 nm. When visible light with an energy distribution similar to sunlight (light of all colors) completely reflects from an object, this light appears white to the human eye. When the object completely absorbs all the light, it is recognized as black.

When we project light through a transparent colored liquid, some light is absorbed and some is transmitted (and reflected). A red liquid transmits mostly red light and absorbs the rest.

This principle is used in colorimetry. Colorimetry is a procedure in which a solution is analyzed by passing selected wavelengths of light (in the visible range) through a solution and measuring the amount of light that is transmitted. Then the absorbed light can be calculated.



The quality (wavelengths) of the absorbed light depends on the molecule dissolved in the solvent. This may help to identify a solute.

The quantity of the absorbed light depends on the concentration of the absorbing solute (see experiment C-28, Beer-Lambert law). This helps when you want to determine the concentration of a solute in a solution.

In this experiment we will investigate the absorbance of red, green, and blue food coloring after irradiating light in red (640 nm), green (524 nm) and blue (470 nm) wavelengths.

Procedure

Experiment setup

1. Set up the experiment as shown in the picture below.

2. Make sure you have three 50 ml beakers, each containing 20 ml of diluted food coloring (red, green and blue).

   It is recommended to dilute the food coloring by 40 (depends on the initial concentration). Make sure you also have three cuvettes.

Sensor setup

3. Connect the USB-200 module  to the PC.

4. Check that the colorimeter sensor  is connected to the USB-200 module.

Note:

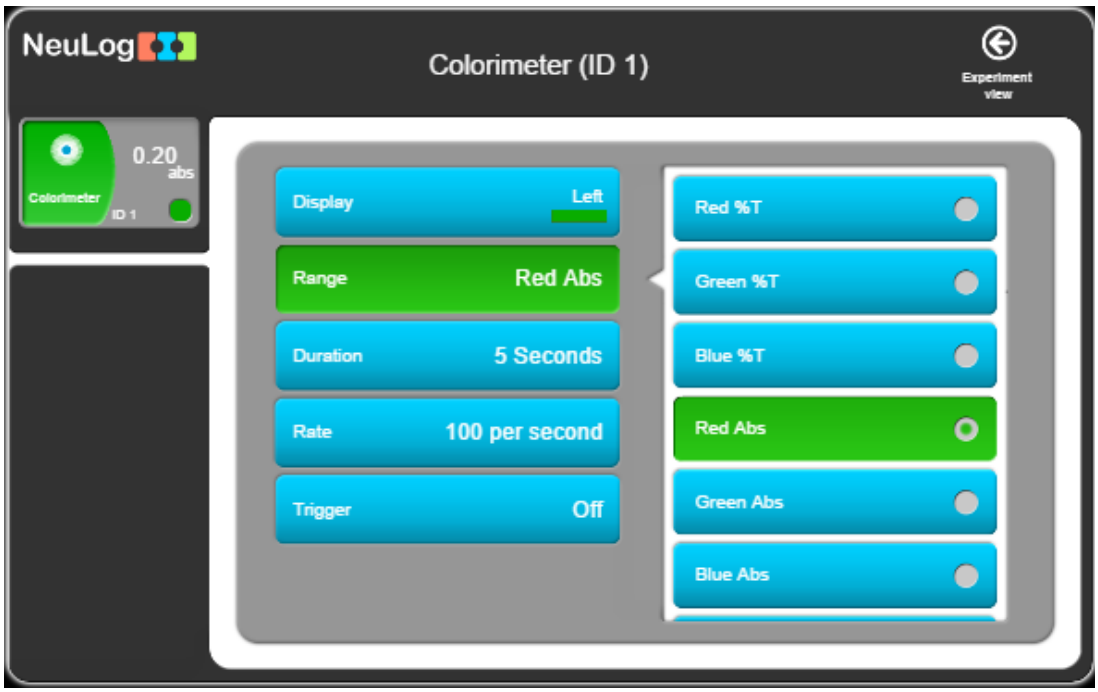
The following application functions are explained in short. It is recommended to practice the NeuLog application functions (as described in the user manual) beforehand.

5. Run the NeuLog application and check that the colorimeter sensor is identified.

Settings

6. Click on the **Sensor's Module** box.

7. Select the "Red Abs" button to change the sensor's mode to absorbance of red wavelengths.



8. This experiment is done in single step mode so the experiment duration and sample rate will not be set.

Testing and measurements

9. Pour the red food coloring into the cuvette so that it will fill a third of it.

10. Place the cuvette in the colorimeter and click on the **Single Step** icon in order to measure absorbance in the red wavelength.

11. Click on the **Table** icon on the bottom part of the screen. A table will be displayed for data record.

12. Fill in the following table with your measurement:

	Light irradiated		
Liquid	Red	Green	Blue
Red food coloring			
Green food coloring			
Blue food coloring			

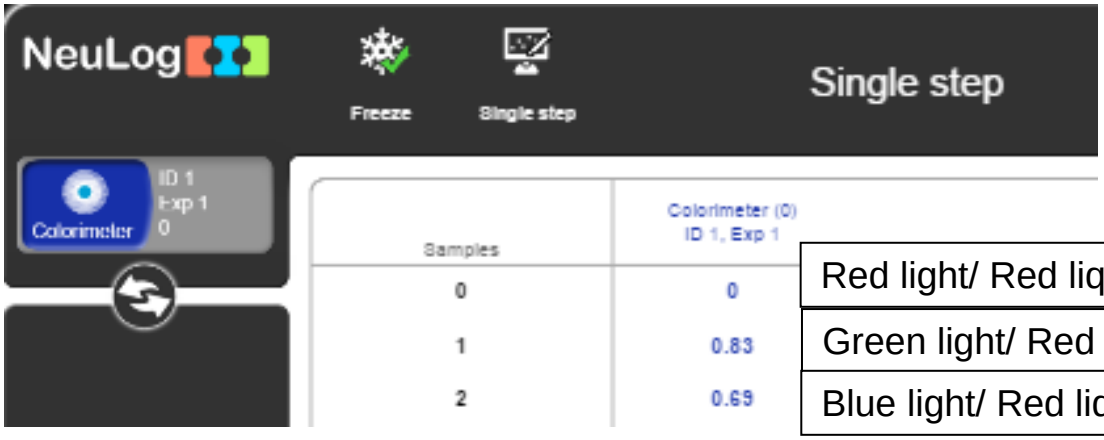
13. Click on the **sensor's Module box** and change the irradiated light to green.

14. Repeat the measurements according to the table in the previous page.

15. Click on the **sensor's Module box** and change the irradiated light to blue.

16. Repeat the measurements according to the table in the previous page.

17. This is an example of irradiating the red food coloring with red, green and blue light.



We can see that the red liquid does not absorb any of the red light (A=0). However, it absorbs green and blue light (A=0.83 and A=0.69 respectively).

Our results are compatible with the concepts discussed in the introduction. When we project light through a transparent colored liquid, some light is absorbed (the colors that we do not see) and the rest is transmitted and reflected (the colors that we do see).

Summary questions

1. Explain the results of the green and blue food coloring measurements.

2. If the liquids were more diluted, how would it affect the results? Explain.

3. What is the best light color (of the colorimeter) for determining the concentration of your red, green and blue food coloring?

4. According to your results, which wavelengths (in terms of colors) do you think chlorophylls use in photosynthesis?