13C - COLORED SOLUTIONS

INQUIRY

How does the light that is absorbed into the solution related to the color of the solution?

MATERIALS

- Device with SPARKvue software
- Colorimeter
- Cuvettes (5)
- Food Coloring (red, green, blue, yellow)
- Wash bottle with distilled water.
- Test tube rack
- Test tubes, 20 mm x 150 mm (4)
- Pipettes, 5, graduated to 1 mL

BACKGROUND

Color is an important part of life and chemistry. If you've ever added a powdered drink mix to water, you realize that the more particles in the drink, the deeper the color of the solution. When we look at something, our eyes are picking up light that is reflecting off that object. Colored objects absorb one or more wavelengths of light, so our eyes only receive part of the visible spectrum. Thus, our brain registers the object as having a color. A red object, for example, might absorb blue, yellow and green wavelengths. Our brain receives the reflected violet, red and orange wavelengths and "averages" them together, making us think we have seen red.

Dyes are chemicals that create color by absorbing specific wavelengths of light. What creates the colors that we see?

SAFETY

Follow these important safety precautions in addition to your regular classroom procedures.

- Wear safety goggles at all times.

PROCEDURE

1. Open SPARKvue.

2. Connect the Colorimeter.

3. Add 3 mL of distilled water into a clean cuvette. This will be used for your reference measurement.

4. Calibrate the colorimeter with the cuvette containing distilled water (the water sample is called a "blank").
   Note: It is important to wipe off the sides of the cuvette before placing it into the colorimeter!

PROCEDURE

5. Open the 13C Colored Solutions lab file in SPARKvue under Experiments > Essential Chemistry.

6. Obtain 10 mL of each of the colored solutions in separate test tubes.

7. Use a pipette to transfer 3 mL of each solution into a cuvette. You should have four cuvettes, each with a different color, plus your "blank" cuvette with water.

8. Place the cap on the cuvettes and wipe off the clear sides. Only handle them by the top of the ribbed sides.

9. Start collecting data.

10. In SPARKvue, the first page shows the Absorbance values of your solution at different wavelengths. Record results of the distilled water (blank) in Table 1.

11. Go to the next page in SPARKvue. This shows the %Transmittance values of your solution at different wavelengths. Record the results of the distilled water (blank) in Table 1.

12. Repeat steps 10-11 for each of your colored solutions.

13. Stop collecting data.

ANALYSIS

Table 1 – Light transmittance and absorbance for solutions of different colors

Solutions	Red light		Orange light		Yellow light		Green light		Blue light		Violet light	
	650 nm		600 nm		570 nm		550 nm		500 nm		450 nm	
	%T	*A*	*%T*	*A*	*%T*	*A*	*%T*	*A*	*%T*	*A*	*%T*	*A*
Water												
Red												
Green												
Blue												
Yellow												

QUESTIONS

1. If a solution has a high transmittance for a certain color of light, what does that mean in terms of photons of light interacting with electrons in the solution? Use specific evidence from Table 1 to justify your answer.

QUESTIONS

2. When a solution has a high transmittance for a certain color of light, does it also have a high absorbance for that color? Use specific evidence from the Data Table to justify your answer.

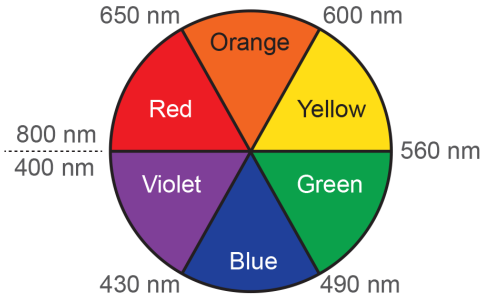
3. Identify the light colors that had the highest absorbance for the following solutions:

   - red solution
   - blue solution
   - yellow solution

4. Do the dye molecules in food color absorb a single color of light or a range of colors? How do you know?

5. When light matches the color of the solution, is it mostly transmitted or absorbed? Justify your answer with data.

6. Consider the color wheel below. Red and green are considered complementary colors, as are violet and yellow. When light is shone through a solution that is a complementary color to that of the solution, is it mostly transmitted or absorbed? Justify your answer with data.



7. What does the absorbance of violet, orange and red lights tell us about the way the green color in our experiment is made?

8. Research the way color books and magazines are printed. Explain the acronym CMYK. Why do printers use CMYK color instead of RGB?

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Analysis

Table 1: Data Table—Light transmittance and absorbance for solutions of different colors

Solutions	Violet light		Blue light		Green light		Yellow light		Orange light		Red light	
	450 nm		500 nm		550 nm		570 nm		600 nm		650 nm	
	A	*%T*	*A*	*%T*	*A*	*%T*	*A*	*%T*	*A*	*%T*	*A*	*%T*
water												
Red												
Green												
Blue												
Yellow												

Questions – Acids

1. If a solution has a high transmittance for a certain color of light, what does that mean in terms of photons of light interacting with electrons in the solution? Use specific evidence from Table 1 to justify your answer.

2. When a solution has a high transmittance for a certain color of light, does it also have a high absorbance for that color? Use specific evidence from the Data Table to justify your answer.

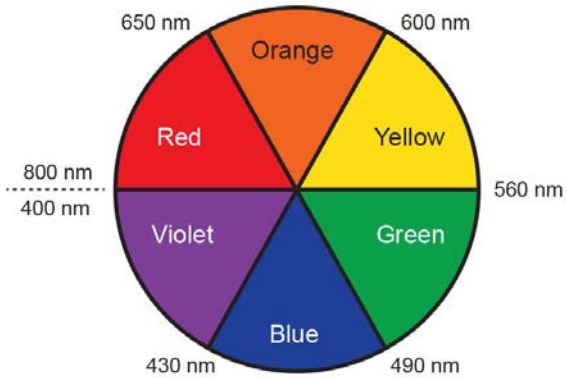
3. Identify the light colors that had the highest absorbance for the following solutions:

   a) red solution b) blue solution c) yellow solution

4. Do the dye molecules in food color absorb a single color of light or a range of colors? How do you know?

5. When light matches the color of the solution, is it mostly transmitted or absorbed? Justify your answer with data.

6. Consider the color wheel below. Red and green are considered complementary colors, as are violet and yellow. When light is shone through a solution that is a complementary color to that of the solution, is it mostly transmitted or absorbed? Justify your answer with data.



7. What does the absorbance of violet, orange and red lights tell us about the way the yellow color in our experiment is made?

8. Research the way color books and magazines are printed. Explain the acronym CMYK. Why do printers use CMYK color instead of RGB?