Colors of Light–Nature's Paint Box

By Marilyn Duerst

Look out the window at the world outside – how many different colors can you see? You might see bright yellow sunflowers, red roses, and green grass. An orange-and-black monarch butterfly might be flitting among the purple irises. If you have a vegetable garden, you might see red tomatoes, or orange pumpkins that are fun to carve into scary faces on Halloween. The leaves on the trees may have turned to brilliant reds, yellows, or oranges.

Did you ever wonder why flowers, fruits, grass, insects, rocks, and bird feathers have color? Or have you wondered the same about the colors in sunsets, crayons, paint, or T-shirts?

Maybe you know that the primary colors of paint and ink are red, yellow and blue — and that purple, orange, and green — or even black — can be made from mixtures of these colors. But you might be surprised to learn that light is very different. The primary colors of light are red, blue, and green, and mixed together they make white light!

Light from the sun or from ordinary light bulbs is sometimes called "white light," but this type of light really consists of all the colors of the rainbow. If you are lucky, you have seen a real rainbow. If the sun is behind your back and "white" light from the sun hits tiny droplets of water that are still in the air at just the right angle, those colors can bend and spread out in a curved shape. Bubbles, peacock feathers, and opals also can bend light and create multi-colored light effects.

If you have ever explored a cave when the guide turned off all the lights, or have been in a totally dark room, you probably saw absolutely nothing. Light from some source must shine on objects so we can see them. Colored objects all around us contain tiny molecules called **pigments** or **dyes** that can absorb (soak up) some of the colors of light, that hit them, and bounce the other colors back to our eyes. For example, grass and leaves look green because the **chlorophyll** molecules in them can absorb all the colors of light that hits them except green, which bounces off and hits our eyes.

In this issue you will learn about how to do some experiments with light and artificial and natural dyes. Have fun with our colorful experiments!

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Why is the Sky Blue and the Sunset Red?

Do you have any idea why the sky usually appears blue, especially in the middle of the day, and the sunrise and sunset often are red or orange? One hint about the answer is that at sunset or sunrise, the sunlight we observe has traveled a longer distance through the atmosphere than the sunlight we see at noon.

To see how this happens, let's pretend that a pitcher or glass filled with water and a little milk is like earth's atmosphere. Then we'll experiment by seeing what happens when light passes through it at different angles.

Materials:

- **Clear glass pitcher or tall glass with straight sides**
- **Milk**
- **A 3″ x 5″ or 4″ x 6″ white index card**
- **Flashlight**

SAFETY SUGGESTION:

Do not taste and materials used in this experiment.

Disposal: All materials used in this experiment can be safely disposed of down the drain with running water.

Procedure:

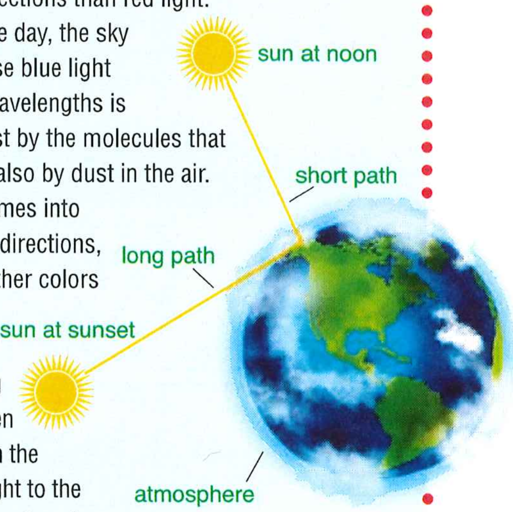
1. Fill a clear glass pitcher or tall glass about 3/4 full with water.
2. Add a few drops of milk and stir until the mixture is slightly cloudy.
3. Darken the room and turn on the flashlight.
4. Shine the flashlight beam through the pitcher or glass from the side. What color is the beam of light, if you look at it from the side?
5. Now hold a white index card at the opposite end of the pitcher or glass from the flashlight, so that the flashlight beam strikes the card. Does the light from the flashlight still look white, or is it a different color?

For a different experiment, shine the flashlight beam up from the bottom, look down into the glass and see if the color of light is still white.

Where's the chemistry?

"White" light consists of all the colors of the rainbow, from violet to blue, green, yellow, orange, and red. Blue and violet light have shorter **wavelengths** than red and orange light, and are much more easily scattered and reflected in all directions than red light.

For most of the day, the sky looks blue because blue light with its shorter wavelengths is scattered the most by the molecules that make up air, and also by dust in the air. This blue light comes into our eyes from all directions, dominating the other colors that are in light from the sun. But in the evening and morning, when the sun is lower in the sky, the path of light to the viewer from the sun travels through a longer distance in the atmosphere, so most of the blue and violet light has been scattered, leaving mostly yellow, orange, and red light that comes to our eyes.



As light passes through the milk/water mixture, the shorter wavelengths (blue and violet) scatter in many directions — even sideways to your eyes. This may give the light beam a bluish tint. The light at the top of the drinking glass (or at the opposite end of the pitcher or tall glass) consists mostly of the red and orange wavelengths. This is because they were not scattered as much, and were able to get all the way though the water.

Diagram from: http://scifun.chem.wisc.edu/homeexpts/bluesky.html

Is Black a Color?

Have you ever wondered why black T-shirts, black crayons, and black marking pens look "black"? Maybe you know that red T-shirts can reflect red light, and green T-shirts can reflect green light, so black T-shirts must reflect NO light. Let's investigate a variety of black markers, and find out why they look "black."

Materials:

- **5 different brands of black markers, both "water-soluble" and "permanent"**
- **5 round, flat coffee filters**
- **Jar, glass, cup or jar lid (such as from a peanut butter jar)**
- **Water and an eyedropper**

Procedure:

1. Lay a flat coffee filter on a flat surface. Choose one of the marking pens and color a solid circle in the center, about ½ inch (about 1 cm) across. With a pencil, label the filter paper with the brand of the marker you are using.
2. Lay the coffee filter over the top of the jar.
3. Drop water onto the center of your black dot. Use 5 to 10 drops, but do so slowly.
4. Observe what happens when the first drop of water hits the black dot, and when you add more drops. What happens to the black dot and its color?
5. Repeat with the other pens on the other coffee filters.
6. Fill out the data table with what you observed for each brand of marker.

SAFETY SUGGESTION:

There are no safety hazards with this experiment. As with any science experiment, eye protection should be worn. In this particular experiment, safety glasses will be sufficient.

Where's the chemistry?

Ancient inks were made with finely-crushed charcoal mixed with sticky liquids from plants called **resins**. Modern black inks in marking pens are usually mixtures of a variety of colored inks mixed with different liquid solvents. In this experiment, as the water moves across the paper by a force called **capillary action**, some parts of the ink (components) are carried further than others. Different brands use different combinations of ink to produce their "black," so each brand separates into its own color pattern.

The original question was, "Is Black a Color?" Each of the colored components in a "black" ink absorbs a portion of the visible light spectrum. If all the visible light has been absorbed by the components in an ink mixture or in any other object, no light bounces off the object and hits our eyes. So we see no color and we describe the object as being black.

Brand of marker	What did you observe?