Why rainbows aren't pink

Color perception is a prime candidate for an optics lesson because children are keenly aware of colors and often already curious about them. If white is a combination of all colors, why do you get a muddy brown when you mix all the paints in your paintbox? Why do people talk about "all the colors in the rainbow" when pink and mint green aren't found in rainbows at all?

Separating colors

One easy way to introduce the subject of color is to create some "rainbows" using sunlight and a hose. Make a fine spray with the hose and stand with your back to the sun. You should be able to adjust the relative angle of the spray and your head to see a rainbow. Another method is to hold a small diamond in sunlight, hold a white paper near the diamond (but not blocking the light), and observe the many small spectrums on the paper. Ask youngsters what colors they see and what colors (such as pink and mint) do not seem to be there.

The next step is to help the child understand that the light from the sun has been spread out into its various wavelength components, or colors. With children under 10, you can simply indicate that the light from the sun has been spread out into lots of colors by the water or diamond. When the water is not in the sun, the colors are gone; this is because it is not the water itself that is colored. Likewise, when the water is taken away, you don't see the colors. It takes both the sunlight and water, because the water is spreading out the light from the sun so you can see its colors.

With older youngsters, if they are interested and asking what causes the color, you can explain that light is a form of energy that travels in waves, and the different colors in the spectrum correspond to different wavelengths. Wavelengths can be demonstrated rather easily with a telephone cord, oscillating the receiver to create standing waves in the cord.

Combining colors

Just as the light from the sun is actually a combination of light of different wavelengths or colors, most light we see is a combination of different wavelengths. Younger children might try the old spinning plate experiment. Have them color a ring near the edge of a white paper plate with radial lines of red, green, and blue. If they put a pencil through the center of the plate and spin it, the colors blend into a nearly neutral grey. Making another ring with only red and blue or only red and green should result in a different color when the plate is spun. Here you are combining light of various colors to make a different color.

With youngsters 12 and older, point out that the light coming off an object such as a shirt depends not only on how the shirt itself reflects light, but on the light that hits it. You can take objects of similar color and compare them under different lights. For example, two pink knit shirts that appear to be the same color under an incandescent bulb may look different under a fluorescent light. If you are lucky enough to have sodium lamps on your street, note how different things look under these lamps. Some clothes will look black.

Perceived colors

We can combine light in any combination of colors and it is not always obvious how the combinations will appear to the human eye. However, psycho-physicists have characterized the visual system and can predict what the apparent color of an object will be to the standard observer. A common way to characterize the appearance of color to the human is in terms of hue, saturation, and brightness. Perhaps you've seen a chromaticity diagram, illustrating hue and saturation.

One way to illustrate these concepts to a youngster is by comparing two glasses of water, one with red food coloring and one with blue. These differ primarily in hue. Slowly adding milk to the red liquid causes a saturation change—the color goes through pink toward white. That is, pink is the same hue as red, but is much less saturated. Similarly, adding milk to the blue liquid will change its saturation toward a powder blue. Brightness can be demonstrated by taking a small amount of water and adding increasing amounts of food coloring, so less light comes through. The transmitted light is decreasing in brightness.

Younger children might enjoy drawing their own pseudo-chromaticity diagram. Have them draw a circle of roughly 4 in. diameter and color some yellow inside the north edge, red at the east, blue at the south, and

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JANET SHIELDS, a past president of the Optical Society of San Diego, is a development engineer working with atmospheric optical systems at Marine Physical Laboratory, Scripps Institution of Oceanography, University of California, San Diego. She is a contributing editor with *Optics & Photonics News.*

IEC/ISO publish standards writing primer

As promised, this month's focus is on the three-volume IEC/ISO Directives for the preparation of international technical standards—*Procedures for the technical work*, *Methodology for the development of International Standards*, and *Drafting and presentation of International Standards*.

The procedures volume details the establishment of technical committees and subsidiary groups, and secretariats to support their work. It then reviews the five stages in the development of International Standards, from proposal through publication, including schedules. Sample document forms for each step are given in the 13 appendices.

The purpose of this first volume is to outline a method of standards writing that yields cost effective and timely standards that will be widely recognized and generally accepted. This is to be accomplished via modern information processing and transfer, as well as modern management techniques to guide the participants toward consensus. In addition, the procedures stress the use of discipline in meeting deadlines and the importance of reaching an early consensus on the national level.

The methodology volume sets out the rules and guidelines to be followed by the IEC and ISO technical committees and subcommittees in developing international standards. The guiding principles are that these standards be comprehensible, unambiguous, and written in a way that will facilitate their adoption as national standards.

Topics covered under methodology include terminology; technical drawings and symbols; units and tolerances; methods of assessing the need for standards; technical requirements for standards to demonstrate the "fitness of purpose" of a product; test methods, sampling, and inspection; designation of standardized items; and marking, labelling, and documentation. The nine appendices include one on certified reference materials.

The final volume is aimed at achieving uniformity in the format of international standards. The text stresses that a standard should be complete, consistent, clear, and accurate. It should take into account the state of the art and yet provide for future technology development. Finally, it should be capable of being understood by qualified persons not involved in its preparation.

To achieve these goals, the document provides general principles for drafting standards; outlines the framework, structure and contents of the standard; and shows how to subdivide it. This is followed by an extensive section on editorial details.

This 280-page, three-volume work on the preparation of international standards should be in the library of anyone working on IEC/ISO standards and in the secretariats of all national subcommittees. The Directives were published in 1989 and are available from ANSI, 1430 Broadway, N.Y. 10018, for a prepayment of $69 that includes postage and handling.

—Robert E. Parks

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green at the west. Next, add the intermediate hues: orange at the northeast, purple in the southeast, blue-green in southwest, and yellow-green at the northwest. Thus, changes along the circumference will correspond to changes of hue. The center of the circle should be colored white and then intermediate saturations are added: pink, halfway between the red and white; powder blue between the blue and white; mint between the green and white; and lemon between the yellow and white. Changes along the radius then correspond to changes of saturation.

Finally, we come back to some of the common questions of children. Where does pink fit into the rainbow? It doesn't. The rainbow colors are what we sense when we look at light of one wavelength. The other colors we perceive are created with combinations of rainbow colors. What about white? White really is created when all colors are reflected back at you. That's different from combining paints, which absorb different wavelengths. If you combine enough paints, most wavelengths will be absorbed a fair amount and the result is fairly dark—that familiar muddy brown.