Color Theory: Defining Brown

Defining Colors

Additive Color
Primaries: Red, GReen, Blue

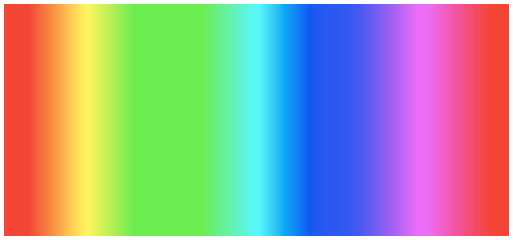
Colors can be defined in many different ways. Computer users are often familiar with colors defined as percentages or amounts of red, green, and blue RGB . Using varying amounts of just those three colors, a computer user can create orange, or lavender, or any other color of the rainbow. But, those color definitions are only appropriate for colors being displayed on the monitor. Printers must define colors differently and instead rely on cyan, yellow, and magenta and, in practice, black , or CMY.

The printer and monitor use different color definitions, or color models, because The printer uses white paper and paints it with darker inks to form colors, but the monitor adds colored light to a black screen. Because the ink on paper subtracts colors from reflecting light, it’s hard to read in the dark. The computer monitor, however, can be read in the dark. In short, a monitor relies on additive color, while the printer relies on subtractive color.

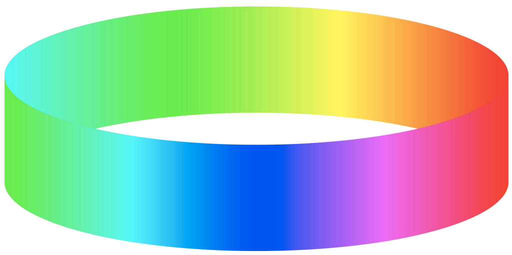
Subtractive Color
Primaries: Cyan, Yellow, Magenta

Though often quick and effective, these RGB and CMY color definitions don’t do a good job of describing the ways we perceive color. Further, they are “device dependant” and converting between them is impossible without understanding perceived color.

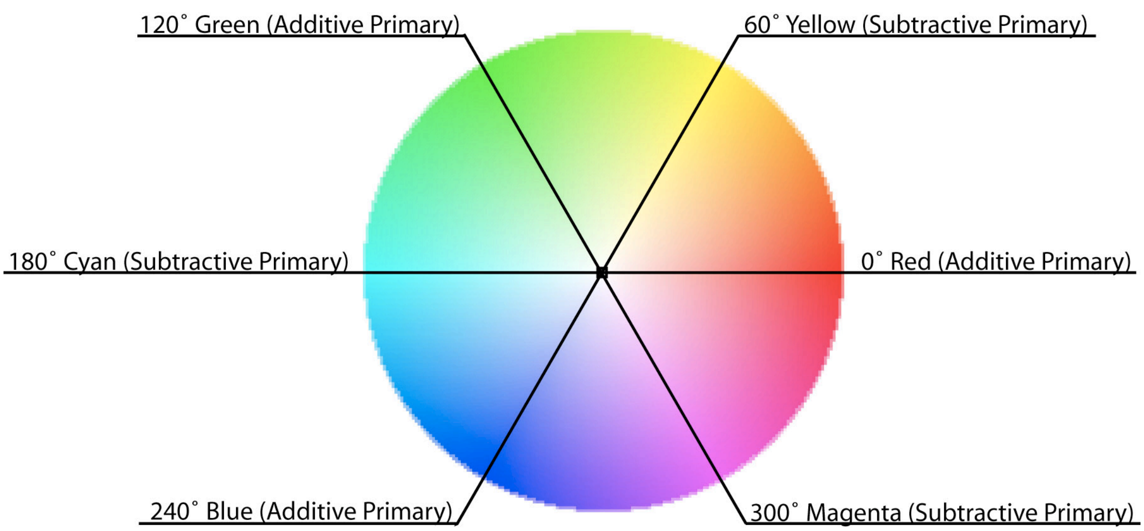
Back to the Start:



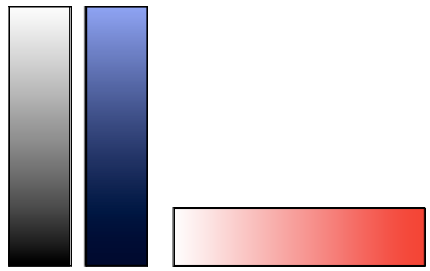
Our eyes perceive a limited range of electromagnetic radiation as visible light. Each wavelength is perceived as a different color. Low frequency visible light is seen as red, while high frequency radiation is seen as violet. Violet or purple, as we all remember from art classes is the result of mixing red and blue. Perceptually, the spectrum of visible light loops to form a circle.



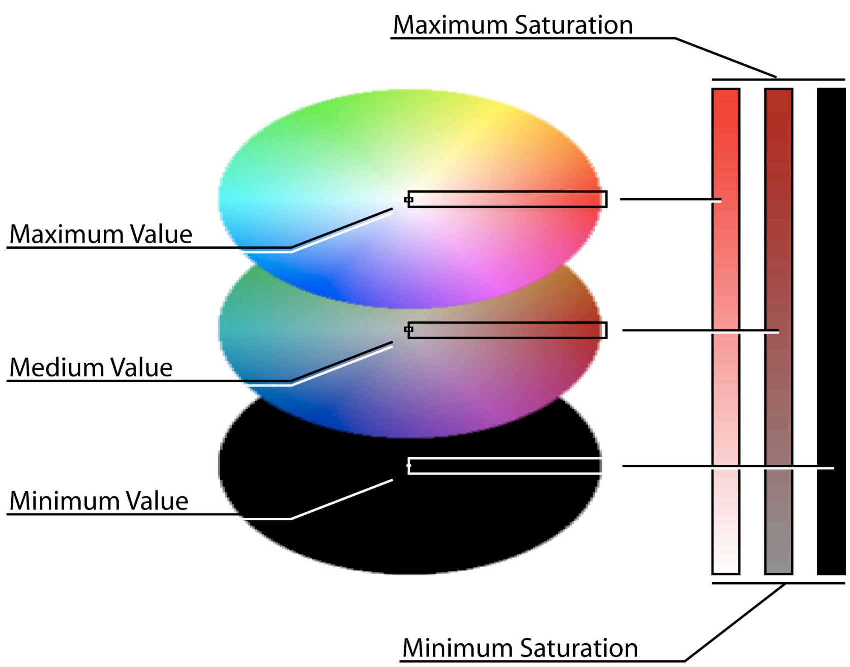
So, we can define color in wavelengths or, because our spectrum forms a circle, we can define colors as angles on that circle. The angle of a color is its hue, and it is just one of the three components of measuring and defining perceptual colors.



The brightness of a color is called its value. Between black and white are many shades of gray, just as between sky blue and navy blue. Each color also has a saturation. Deep red desaturates to salmon, then to unsaturated neutral white, gray, black .



Taken together, hue, saturation, and value define colors in a three dimensional volume. Below are three circles of this theoretical cylinder actually, a cylinder is a gross simplification, but deal with it . Saturation increases with distance from the center, value increases vertically, and hue are represented by degree. The 0° radial of each circle is shown in detail.



The diagram above represents the HSV hue, saturation, value model, developed in the 1930s by the Commission Internationale d'Eclairage CIE .[1] The CIE is also responsible for at least two other color models including HLS hue, lightness, saturation , which is almost identical to the HSV model and similar to Munsell's color solid, and XYZ, a system that may better express the range of visible color at the expense of describing color relationships.

[1] Color Spaces. Retrieved June 3, 2002 from the World Wide Web: http://developer.apple.com/techpubs/mac/ACI/ACI-48.html

What does this have to do with brown?

Yellow exists as a perceptual anomaly. We commonly define light blue, dark green, and deep red. And, while we can go into any paint store and ask for "light yellow," you won't find "dark yellow" in the color samples. If we plot the 60° radial in two dimensions with saturation on the horizontal and value on the vertical axis, we get this:

An analysis of three light brown beverages reveals the following:

A. B. C.

A. has an average hue of 45°, 100 saturation, and 85 value.
B. has an average hue of 40°, 80 saturation, and 85 value.
C. has an average hue of 50°, 80 saturation, and 90 value.

The numbers show a tendency toward red orange, but are still very close to yellow's 60° hue angle. The numbers also show small changes in saturation and value affect color.

Yeah, whatever. Brown is what happens when I spill all my paints together.

Well, you're right. Paints are never as pure as our theoretical colors. Paints, even primaries, are rarely chosen for their true mixing properties. Artists want bright reds, not magenta. Cyan is only really good for painting victims of carbon monoxide poisoning, so most artists buy deeper blues.

Even when colors are selected for their mixing properties, as in color printers, engineers are often forced to make trade offs between color accuracy and "vibrancy" that customers seem to expect. Yellows are often brighter than prime yellow. When mixed together, the results are often skewed toward brown.

When working with light, or additive color, our eyes are often very forgiving. We see yellow where we expect yellow, even when lights are dim. Color perception is subject to all the vagaries of sensory perception. We see a brown dogs and yellow caution lights, even though both may have the same value, saturation, and hue.

People who agree with me:

http://developer.apple.com/techpubs/mac/ACI/ACI_48.html
http://www.adobe.com/support/techguides/color/colormodels/main.html
http://www2.ncsu.edu/scivis/lessons/colormodels/color_models2.html