Color Models

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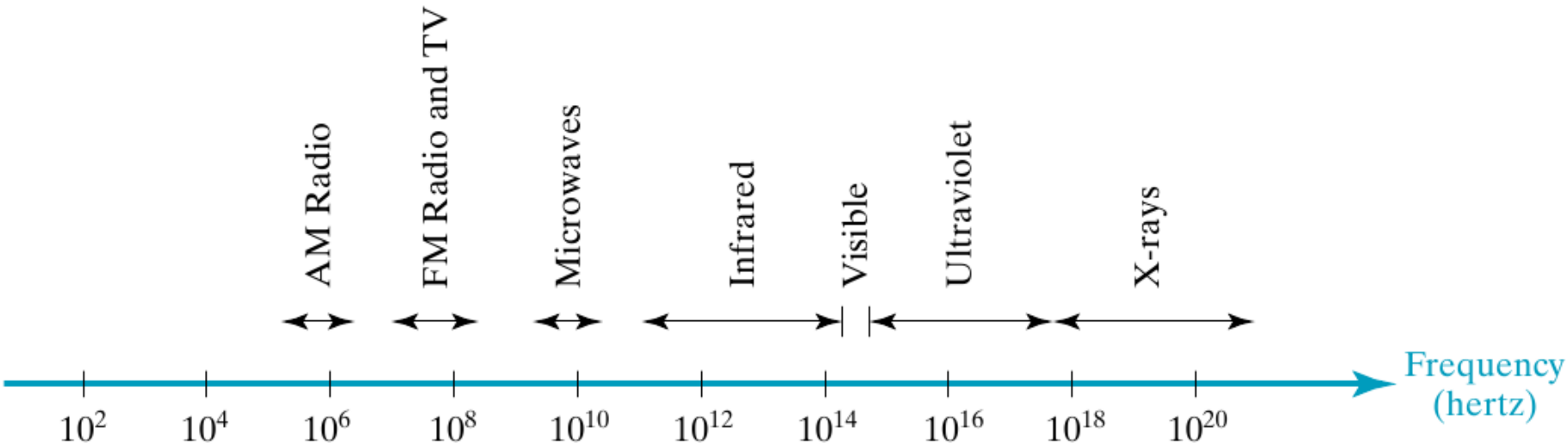
Electromagnetic Spectrum



Energy Distribution

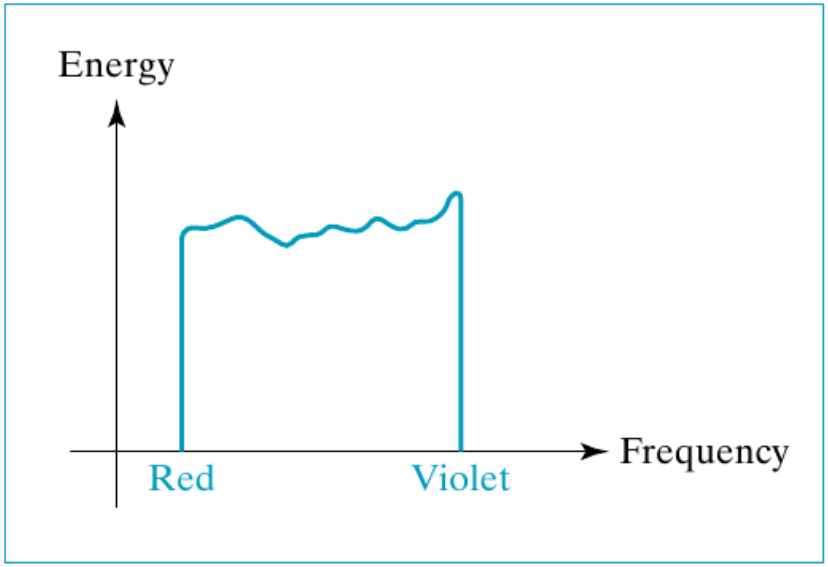


FIGURE 12–3 Energy distribution for a white light source.

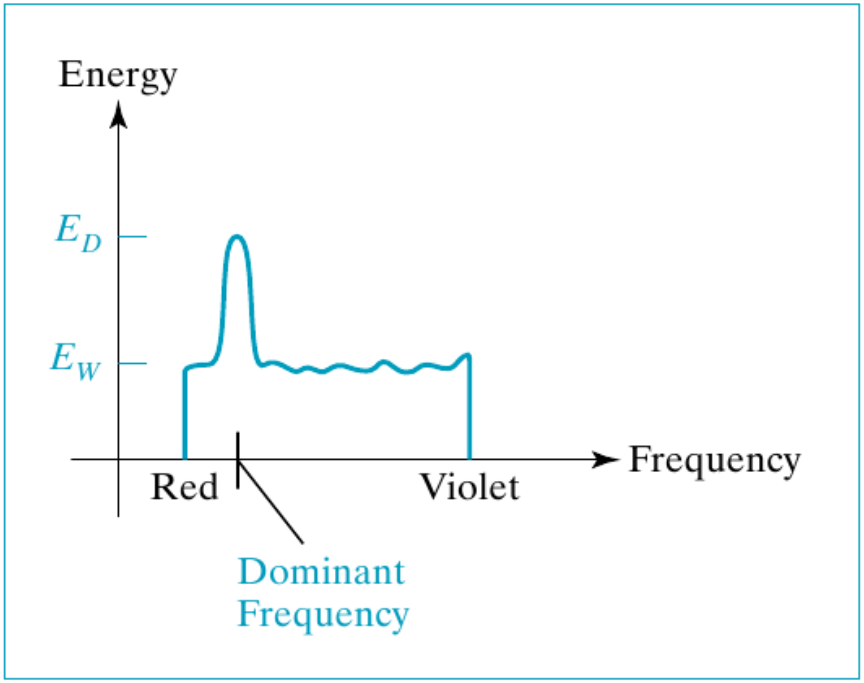


FIGURE 12–4 Energy distribution for a light source with a dominant frequency near the red end of the frequency range.

Primary Colors

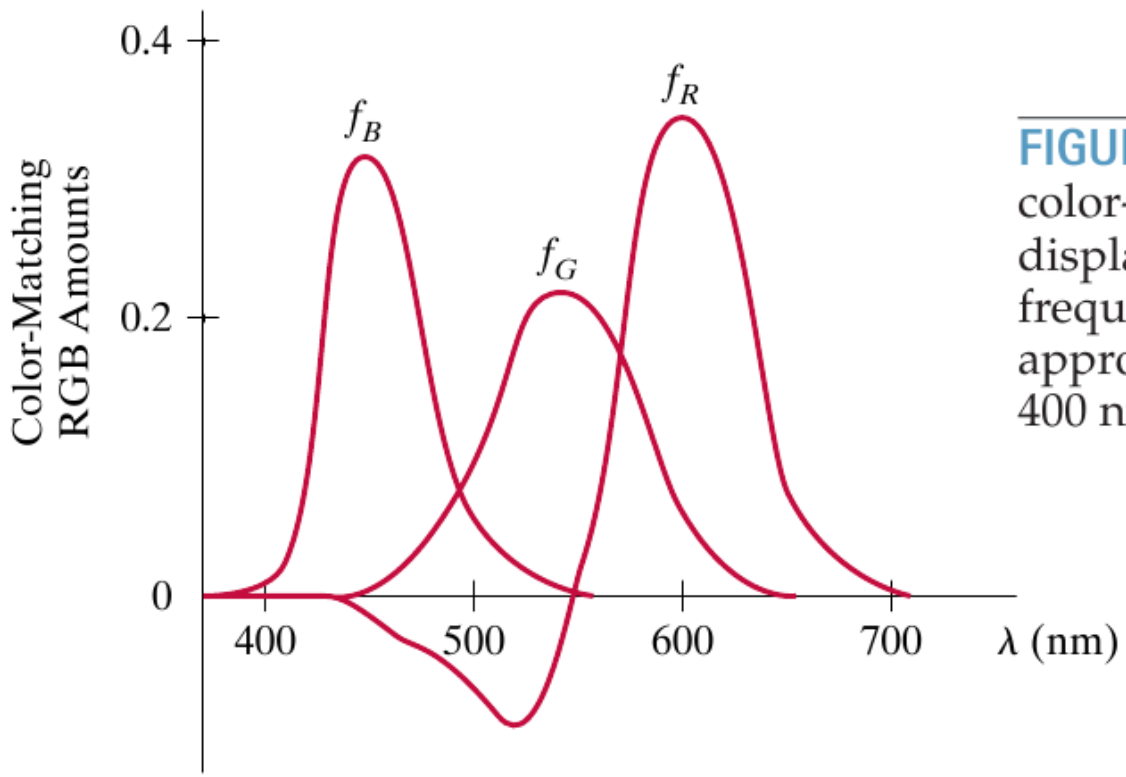


FIGURE 12–5 Three color-matching functions for displaying spectral frequencies within the approximate range from 400 nm to 700 nm.

The CIE Chromaticity Diagram

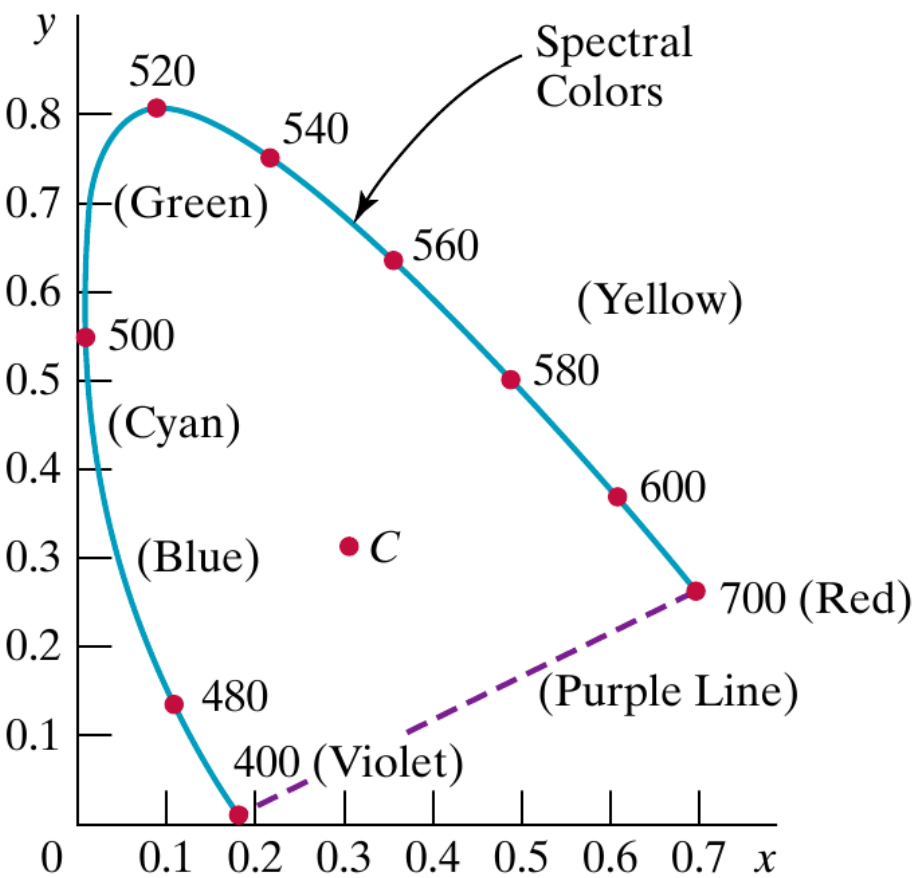


FIGURE 12–7 CIE chromaticity diagram for the spectral colors from 400 nm to 700 nm.

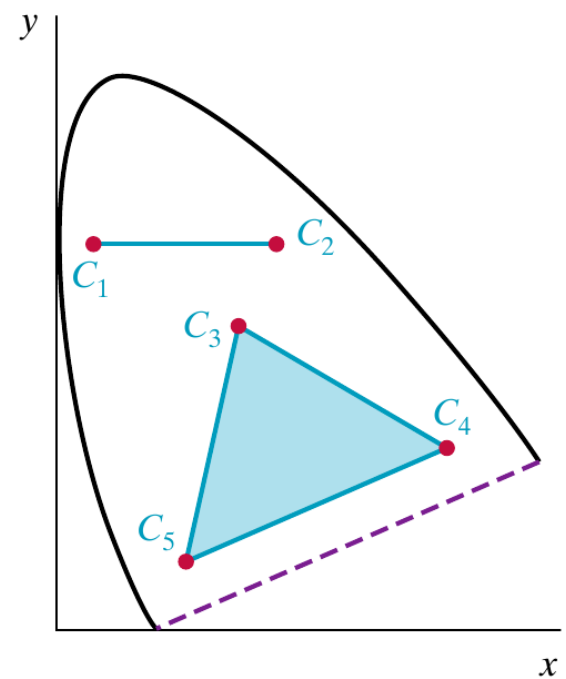
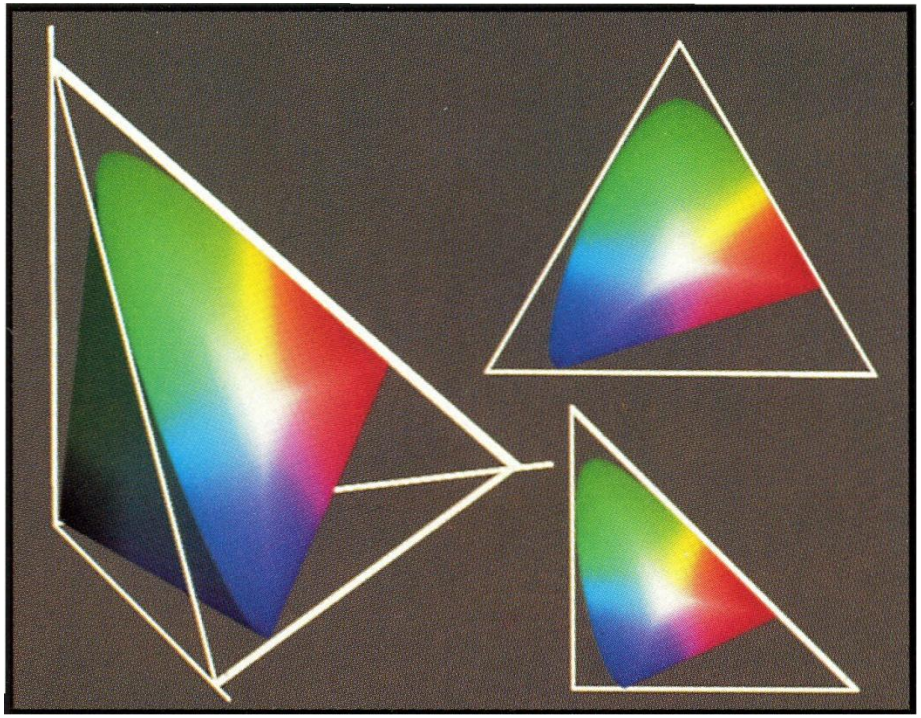
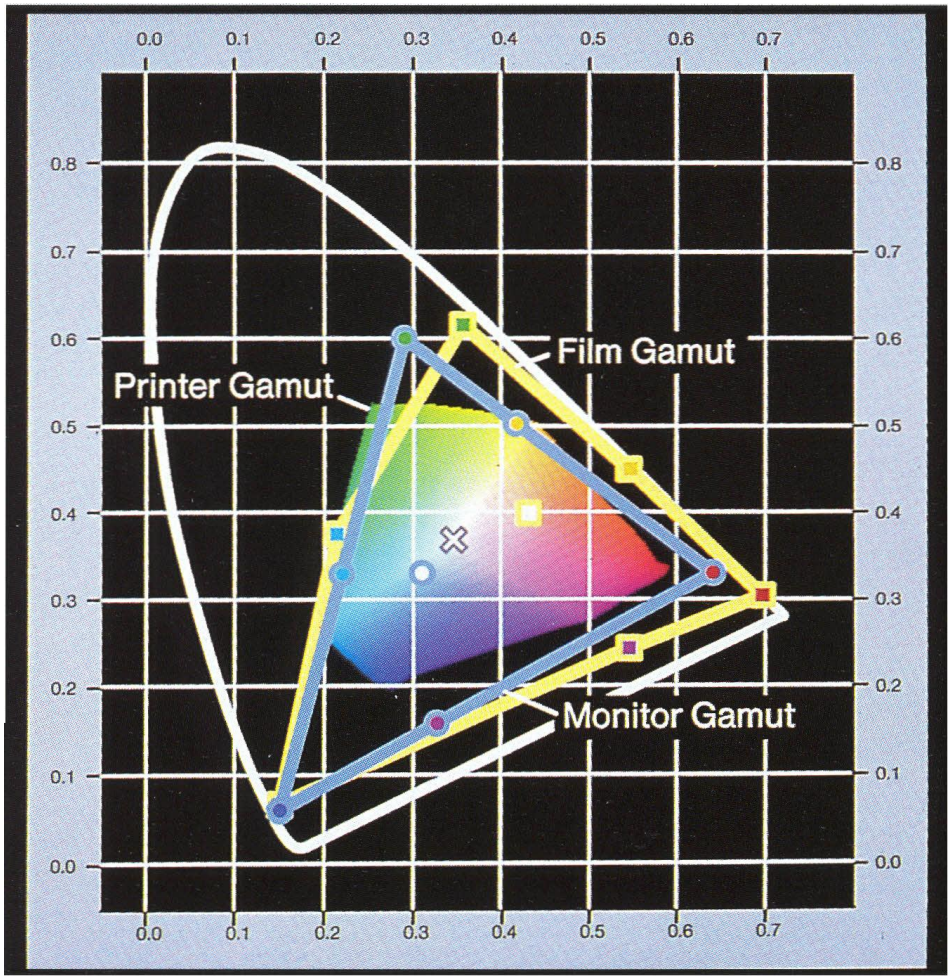


FIGURE 12–8 Color gamuts defined on the chromaticity diagram for a two-color and a three-color system of primaries.

CIE Chromaticity Diagram





The RGB Color Model

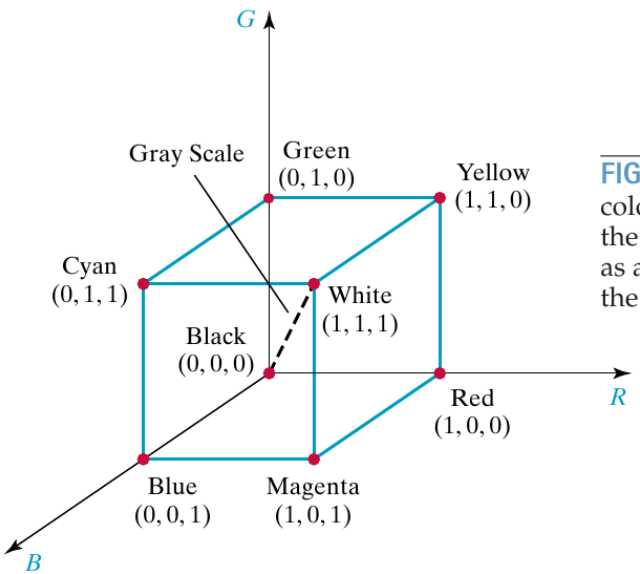


FIGURE 12–11 The RGB color model. Any color within the unit cube can be described as an additive combination of the three primary colors.

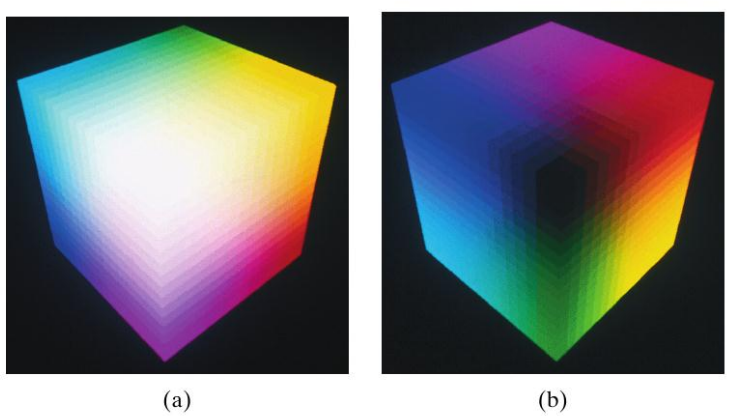


FIGURE 12–12 Two views of the RGB color cube. View (a) is along the gray-scale diagonal from white to black, and view (b) is along the gray-scale diagonal from black to white.

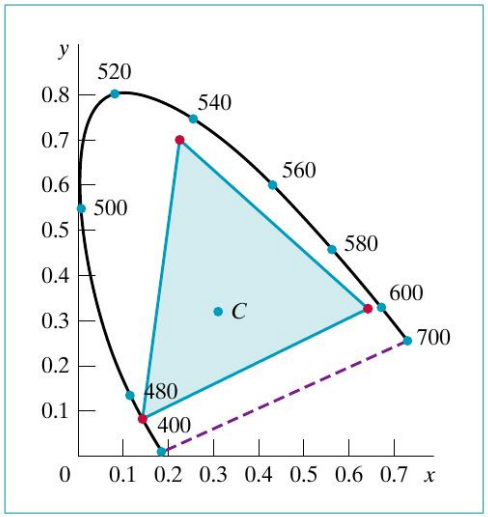


FIGURE 12–13 The RGB color gamut for NTSC chromaticity coordinates. Illuminant C is at position (0.310, 0.316), with a luminance value of $Y = 100.0$.

The YIQ Color Model

$$Y = 0.299\,R + 0.587\,G + 0.114\,B$$

$$I = R - Y$$

$$Q = B - Y$$

$$\begin{bmatrix} Y \\ I \\ Q \end{bmatrix} = \begin{bmatrix} 0.299 & 0.587 & 0.114 \\ 0.701 & -0.587 & -0.114 \\ -0.299 & -0.587 & 0.886 \end{bmatrix} \cdot \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} 1.000 & 1.000 & 0.000 \\ 1.000 & -0.509 & -0.194 \\ 1.000 & 0.000 & 1.000 \end{bmatrix} \cdot \begin{bmatrix} Y \\ I \\ Q \end{bmatrix}$$

CMY and CMYK Color Models

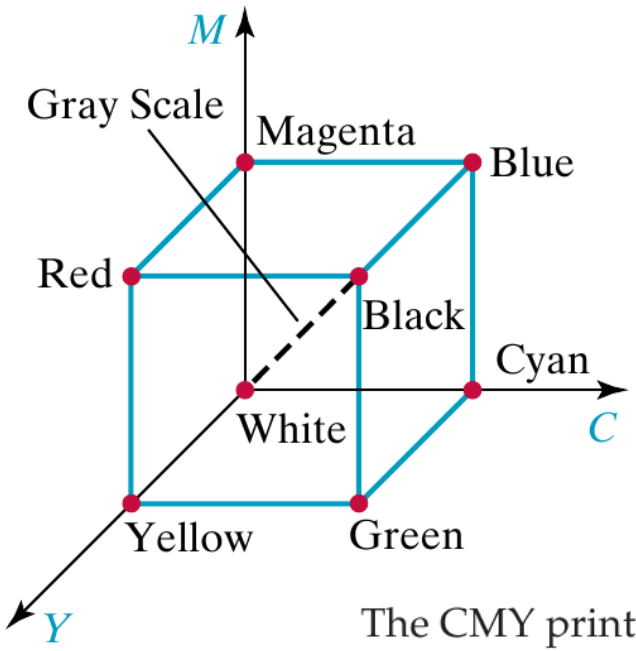
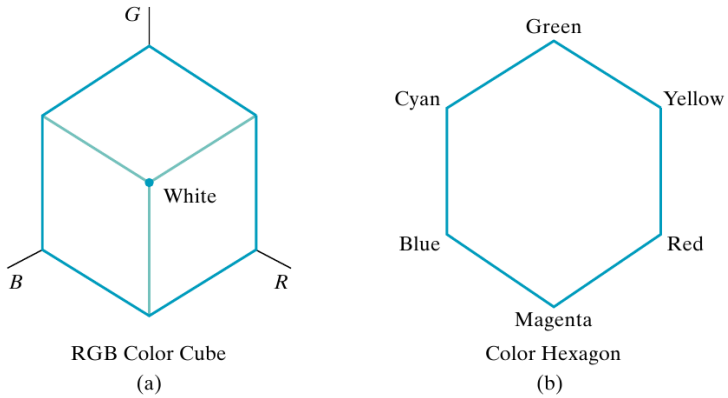


FIGURE 12–14 The CMY color model. Positions within the unit cube are described by subtracting the specified amounts of the primary colors from white.

The CMY printing process often uses a collection of four ink dots, which are arranged in a close pattern somewhat as an RGB monitor uses three phosphor dots. Thus, in practice, the CMY color model is referred to as the CMYK model, where K is the black color parameter. One ink dot is used for each of the primary colors (cyan, magenta, and yellow), and one ink dot is black. A black dot is included because reflected light from the cyan, magenta, and yellow inks typically produce only shades of gray. Some plotters produce different color combinations by spraying the ink for the three primary colors over each other and allowing them to mix before they dry. For black-and-white or gray-scale printing, only the black ink is used.

HSV and HLS Color Models



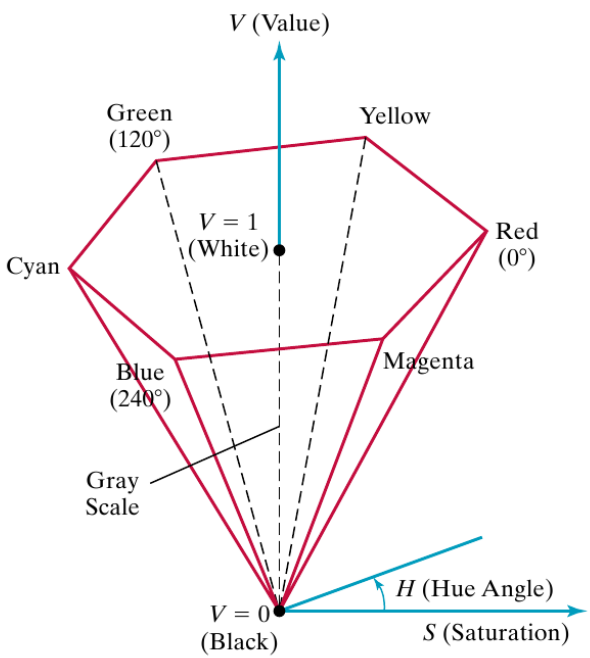


FIGURE 12-16 The HSV hexcone.

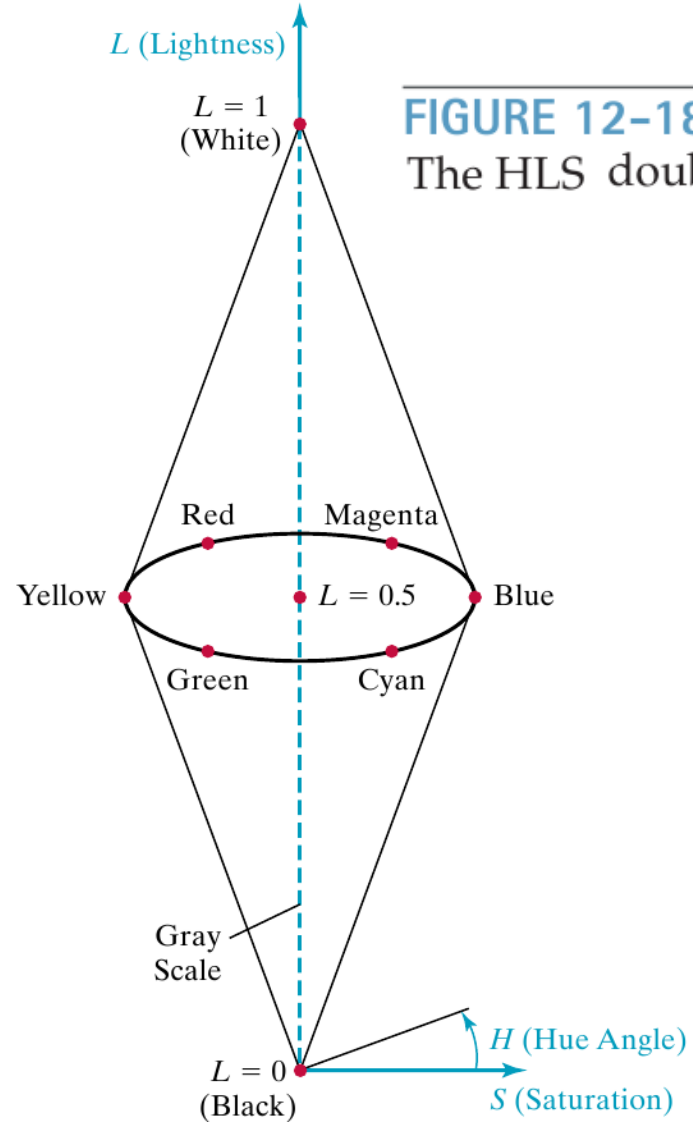


FIGURE 12-18 The HLS double cone.