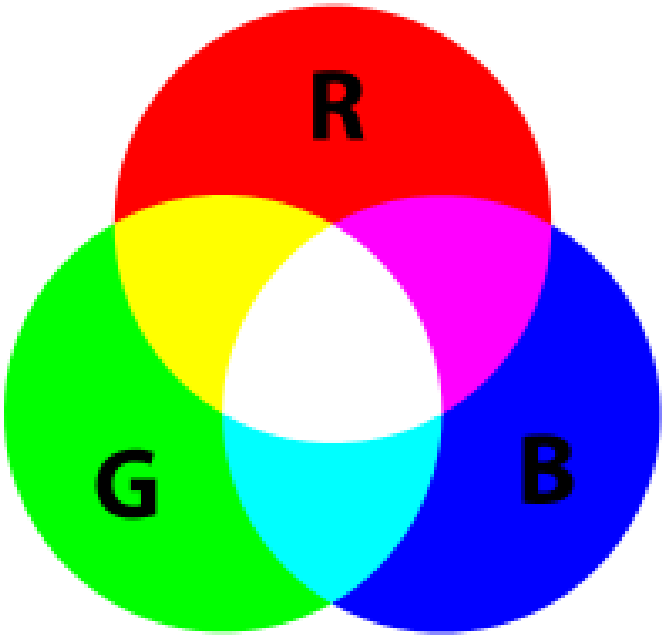
Color Space

A color space is a specific organization of colors



Additive color mixing: Three overlapping lightbulbs in a vacuum, adding together to create white.

RGB : RGB (Red, Green, Blue) describes what kind of *light* needs to be *emitted* to produce a given color. Light is added together to create form from darkness.

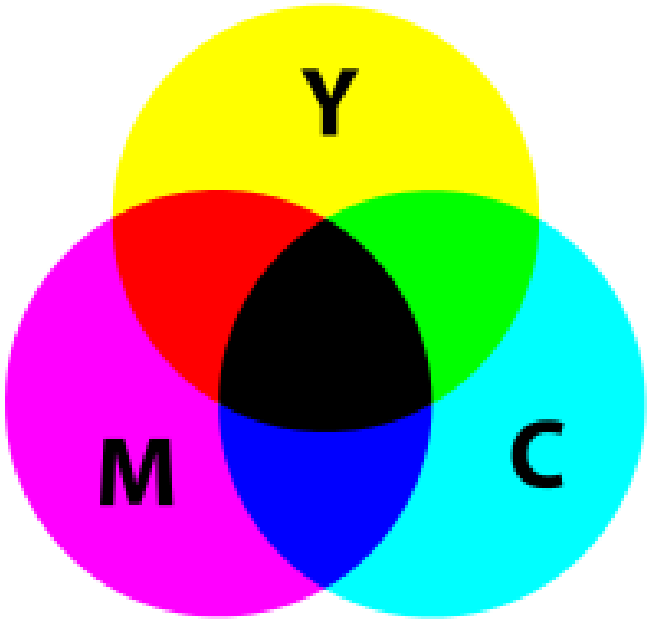
YIQ, YUV : YIQ was formerly used in NTSC (North America, Japan and elsewhere) television broadcasts for historical reasons. This system stores a luma value with two chroma or chrominance values, corresponding approximately to the amounts of blue and red in the color. It corresponds closely to the YUV scheme used in PAL (Australia, Europe, except France, which uses SECAM) television except that the YIQ color space is rotated 33° with respect to the YUV color space.

YCbCr : YCbCr, used widely in video and image compression schemes such as MPEG and JPEG.

HSV : (**h**ue, **s**aturation, **v**alue), also known as HSB (hue, saturation, **b**rightness), is often used by artists because it is often more natural to think about a color in terms of hue and saturation than in terms of additive or subtractive color components.

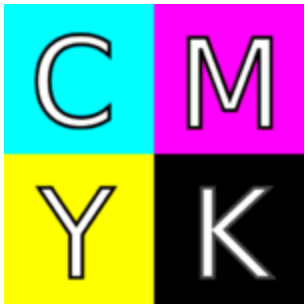
CMYK : CMYK is used in the printing process, because it describes what kind of inks need to be applied so the light reflected from the substrate and through the inks produces a given color.

CMY Color Space



$$\begin{bmatrix} C \\ M \\ Y \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} - \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} - \begin{bmatrix} C \\ M \\ Y \end{bmatrix}$$



HSV

HSV stands for hue, saturation, and value. These terms have the following meanings:

Hue: The “true color” attribute (red, green, blue, orange, yellow, and so on).

Saturation: The amount by which the color has been diluted with white. The more white in the color, the lower the saturation. So a deep red has high saturation, and a light red (a pinkish color) has low saturation.

Value: The degree of brightness: a well-lit color has high intensity; a dark color has low intensity.

$$V = \max\{R, G, B\}$$
$$\delta = V - \min\{R, G, B\}$$
$$S = \frac{\delta}{V}$$

$$\text{if } R = V \text{ then } H = \frac{1}{6}\frac{G - B}{\delta}$$
$$\text{if } G = V \text{ then } H = \frac{1}{6}\left(2 + \frac{B - R}{\delta}\right)$$
$$\text{if } B = V \text{ then } H = \frac{1}{6}\left(4 + \frac{R - G}{\delta}\right)$$

YIQ

This color space is used for TV/video in the United States and other countries where NTSC is the video standard (Australia uses PAL). In this scheme, Y is the "luminance" (this corresponds roughly with intensity), and I and Q carry the color information. The conversion between RGB is straightforward:

$$\begin{bmatrix} Y \\ I \\ Q \end{bmatrix} = \begin{bmatrix} 0.299 & 0.587 & 0.114 \\ 0.596 & -0.274 & -0.322 \\ 0.211 & -0.523 & 0.312 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

and

$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} 1.000 & 0.956 & 0.621 \\ 1.000 & -0.272 & -0.647 \\ 1.000 & -1.106 & 1.703 \end{bmatrix} \begin{bmatrix} Y \\ I \\ Q \end{bmatrix}$$

Pseudo Coloring