Color Appreciation

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Color Appreciation

- Color theory
- Additive color system
- Subtractive color system
- Color communication
- Color viewing

Color

- *A phenomenon of light*
- *A visual sensation*

Phenomenon

- *Known through the senses, rather than through thought or intuition*

Theory

- *A scientifically acceptable general principle offered to explain phenomenon*
- *An unproved assumption*

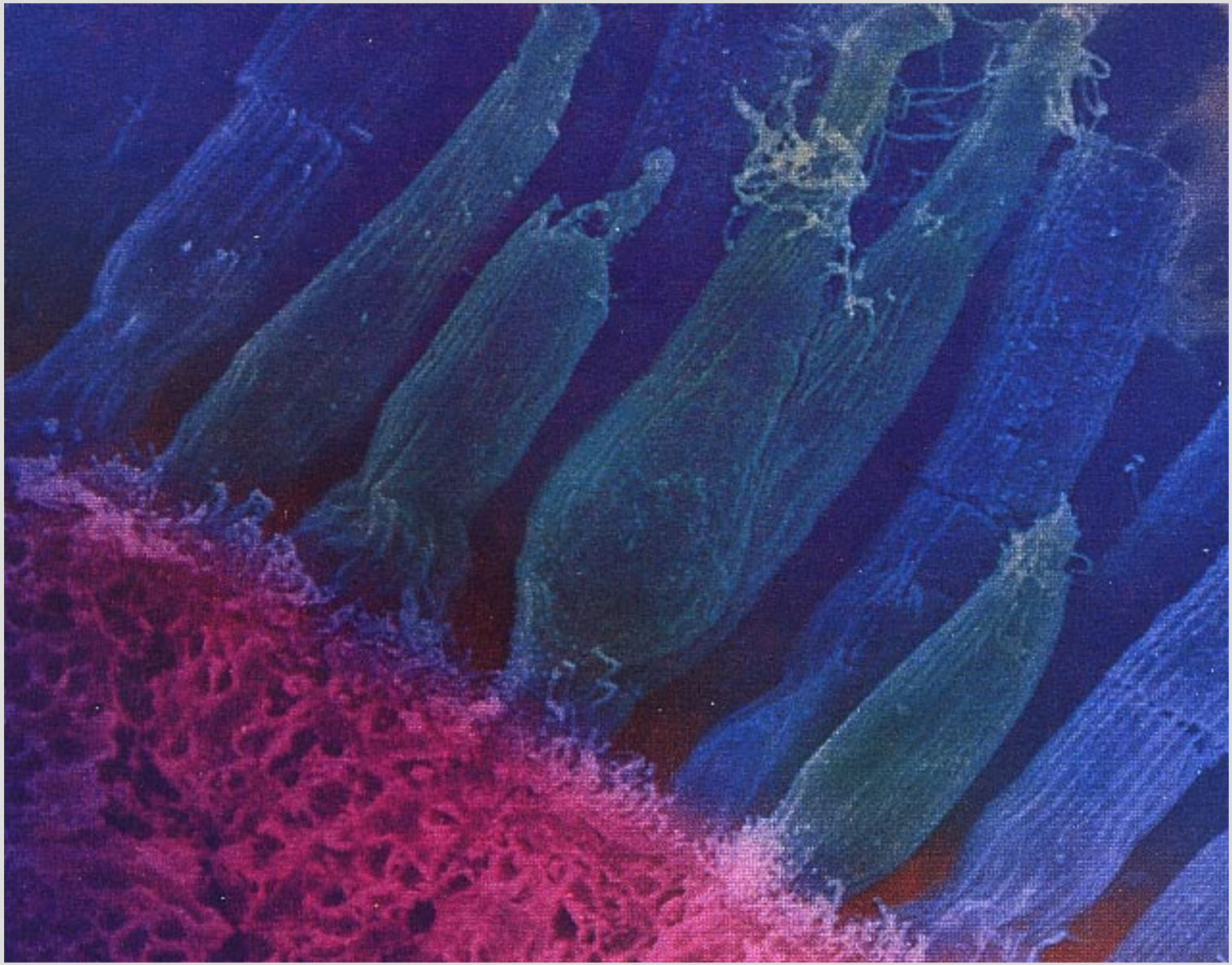
Color

- All color is in light
  - *Without light there is no color*
- Light is radiant or electromagnetic energy
- The absence of ***light*** is ***black***

The Physical Origins of Color

- ***Rods***—A type of nerve ending in the eye that is sensitive to low levels of light. Responsible for night vision.
- ***Cones***—A type of nerve ending in the eye that can distinguish between the individual components of light.
  - *This ability to distinguish between the individual components of the light creates the sensation we call color. If you had no cones in your eyes, color would not exist.*

Rods and Cones

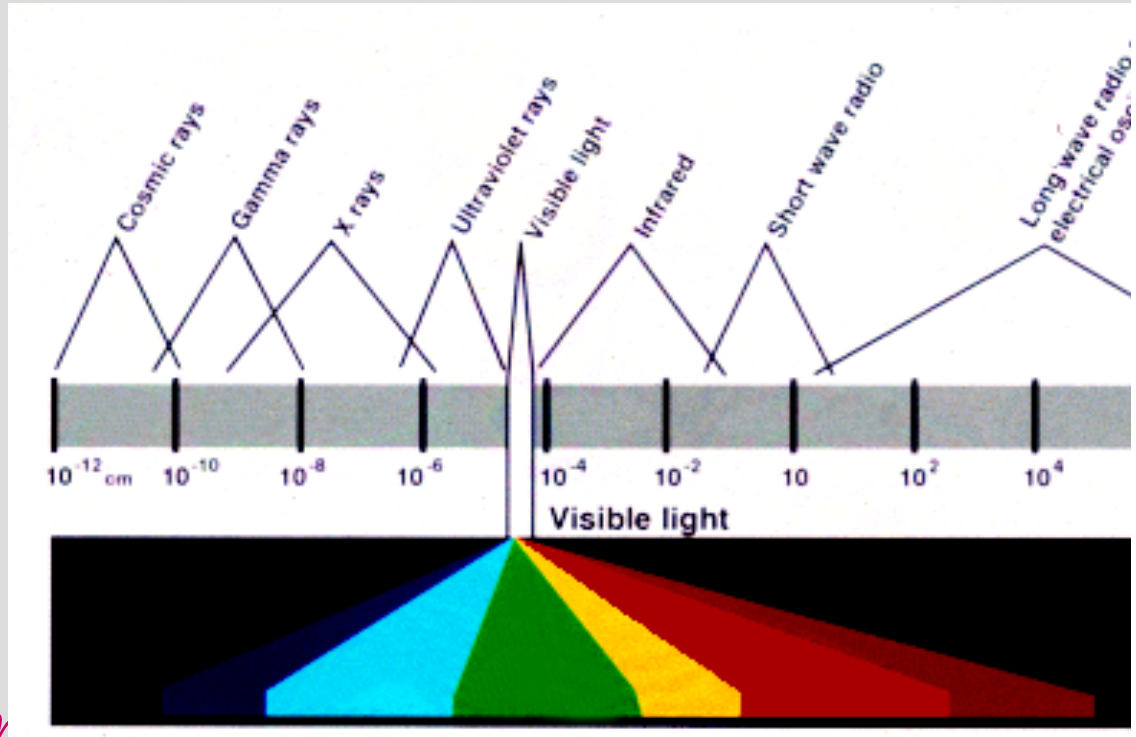


Color

- If an ideal white light were perfectly dissected by the use of a prism, it would reveal three beams known as the ***primary colors of light***
- We have been taught to call these visual sensations by the names ***red***, ***green*** and ***blue***
- Nearly every color you see can be created by a combination of red, green and blue light

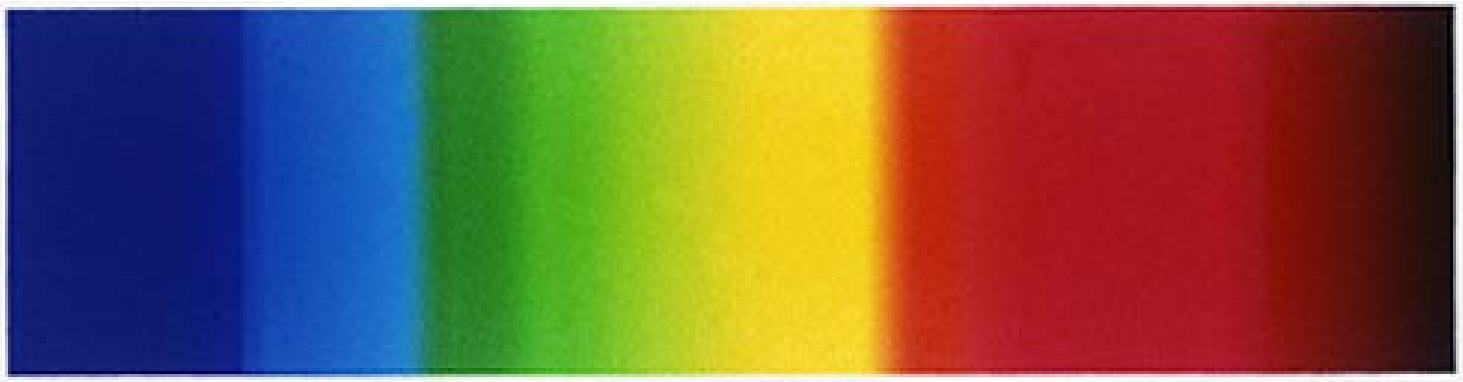
Color

- Visible light has been classified as the narrow range of electromagnetic energy located near the center of the electromagnetic spectrum
- The human eye is sensitive to only a portion of this electro-magnetic range, which we call the ***visible spectrum***



Color

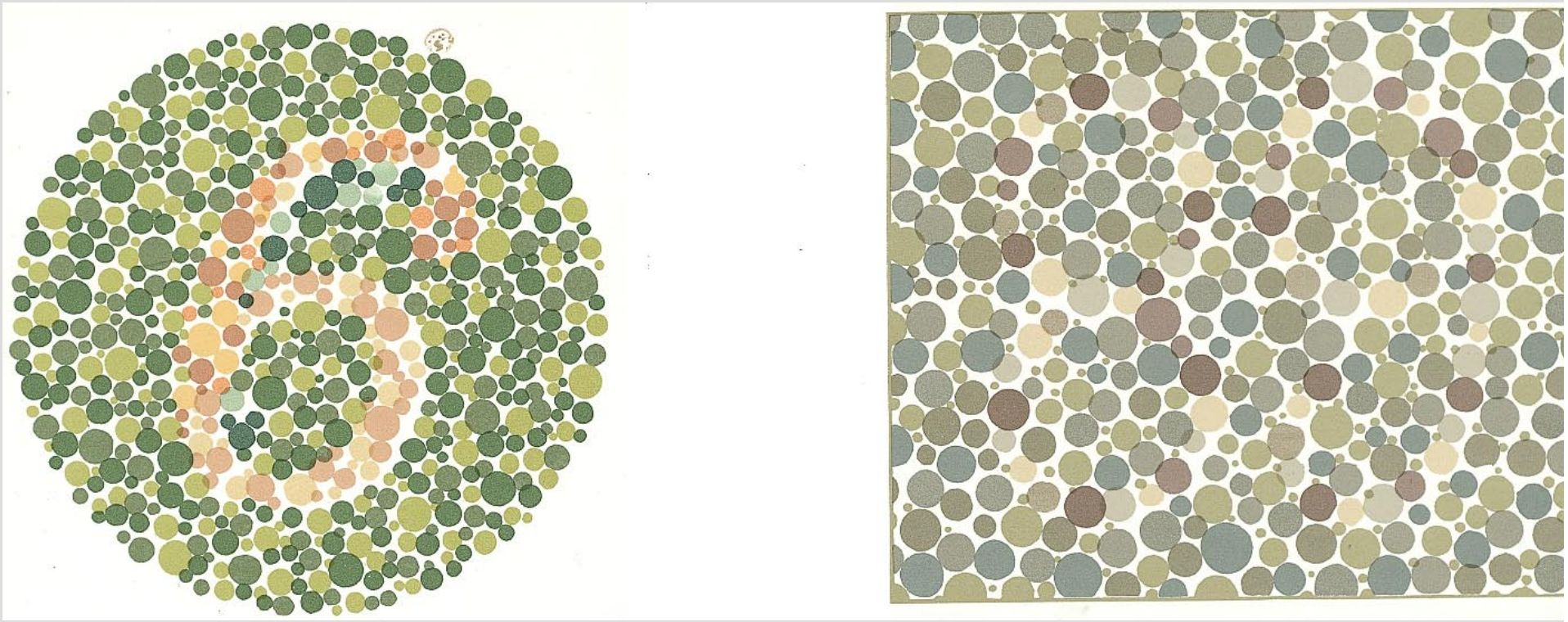
- The visible spectrum ranges from approximately 400 nanometers (blue) to 700 nanometers (red)
  - *A nanometer is one billionth of a meter*
  - *The human eye can't perceive energy outside this range*
- People who can't distinguish between primary colors within this range are referred to as color deficient
  - *8 to 10% of the male population is color deficient*
  - *Only 1/2 of 1% of the female population is color deficient*



Color Perception

- All people involved in the color reproduction process should take a color deficiency test
  1. *Production people*
  2. *Customer service representatives*
  3. *Sales personnel*
  4. *Client (The client is the color expert!)*
- The leading color deficiency test is the *Pseudo-isochromatic Test for Color Perception*
  - *Available from Richmond Products, 1021 S. Rogers Circle, Boca Raton, FL 33487*

Color Perception



Representative images from the
Pseudo-isochromatic Test for Color Perception

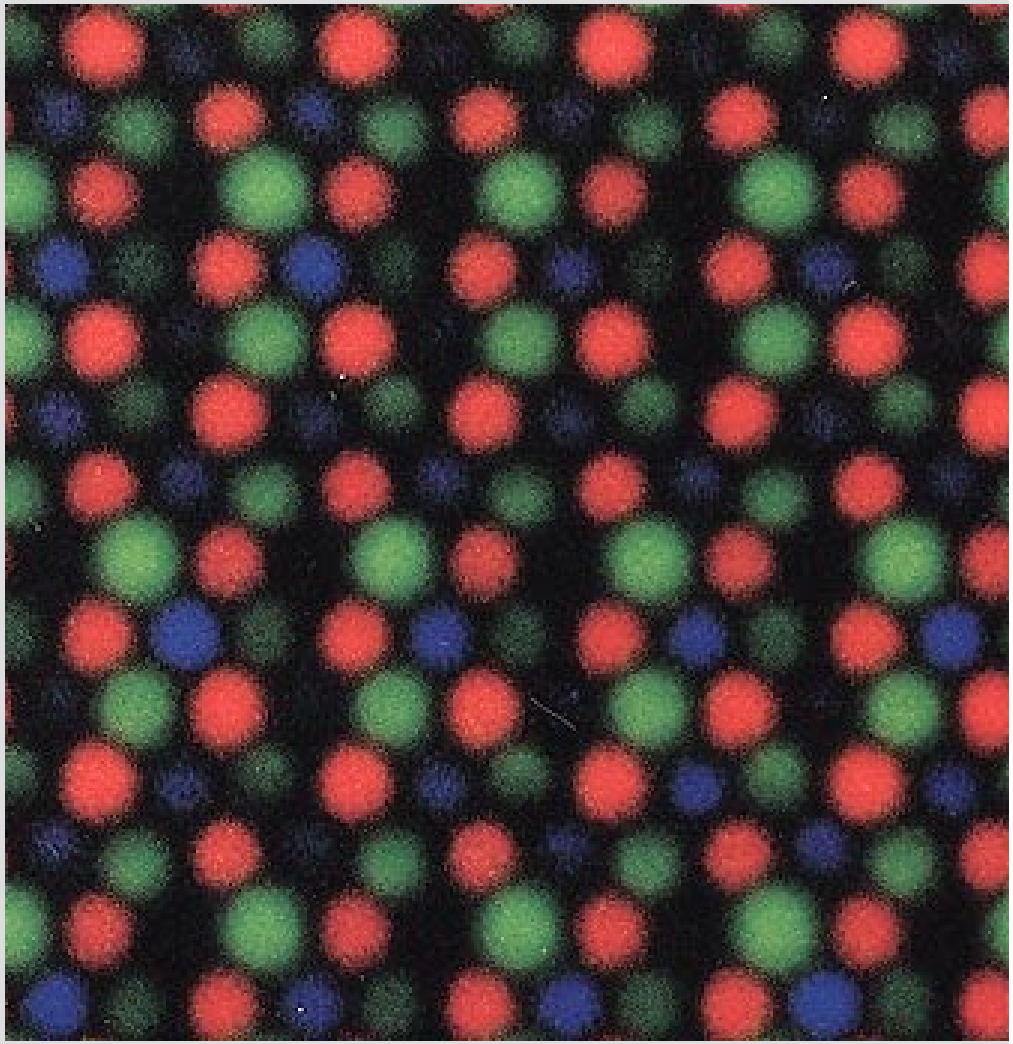
The Additive Color System

- ***Additive color*** starts with a black background
- White light is added in different proportions to reproduce a spectrum of color
  - *The light appears white because it contains a balanced amount of red, green and blue light*
- Examples of devices which use the additive color system include:
  - *Color monitors*
  - *Stage lighting*
  - *Video projectors*

Additive Color

Additive Color

- The red, green, and blue mosaic of a color TV screen (or computer monitor) is a source of ***additive*** color



The Subtractive Color System

- The ***subtractive color system*** starts with a white background
- The paper is white because it reflects the full spectrum of light (R+G+B) to the eye
  - *We call that "white light"*
- Control over color is in the paper—and the inks that we print on the paper's surface
- Printing processes that utilize pigments (printing inks) reproduce full-color images using subtractive color

Subtractive Color

Subtractive Color Reproduction

- ***Subtractive color*** is the process of removing colors from the white surround
- The subtractive color system works best with a white background
  - *The "whiter" your surround is, the more colors you can reproduce (color gamut)*

The Role of Printing Inks

- Inks serve as filters on the surround
- We can reproduce a broad range of colors if our inks are the subtractive primaries
  - *Cyan, magenta, and yellow*
- When we combine two primary colors, the result is called a ***secondary*** color
- We print with inks colored cyan, magenta, and yellow because they are the perfect filters for subtracting red, green, and blue!

The Subtractive Process

- To remember what part of light is subtracted to get an ink (on white paper), follow this:

CYAN ink subtracts most of the **RED** light

MAGENTA ink subtracts most **GREEN** light

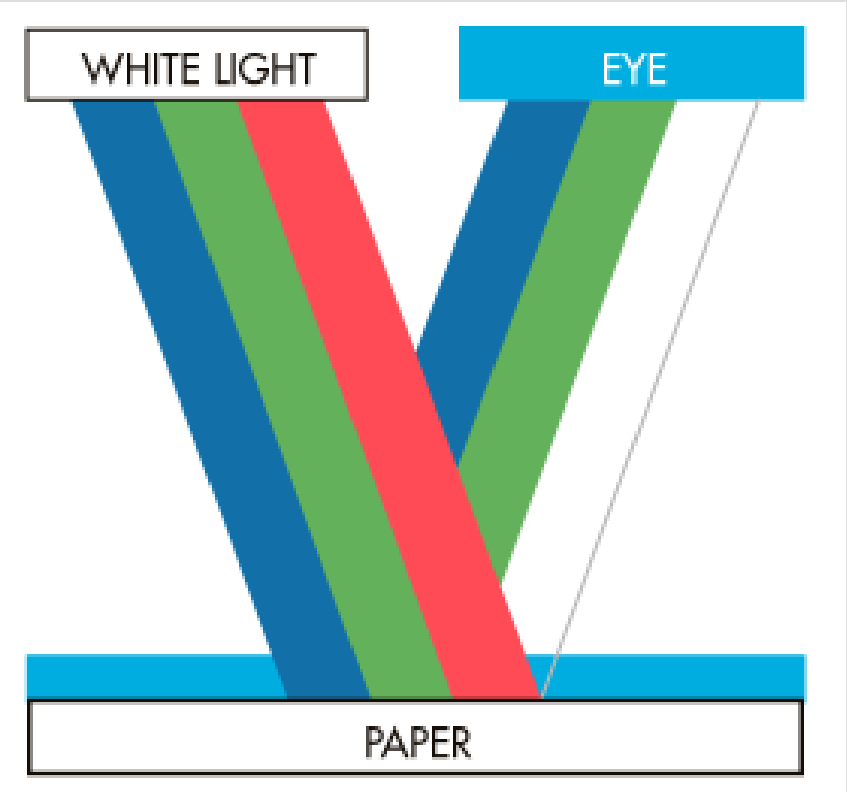
YELLOW ink subtracts mo st **BLUE** light

- *There are no pure inks that subtract everything!*

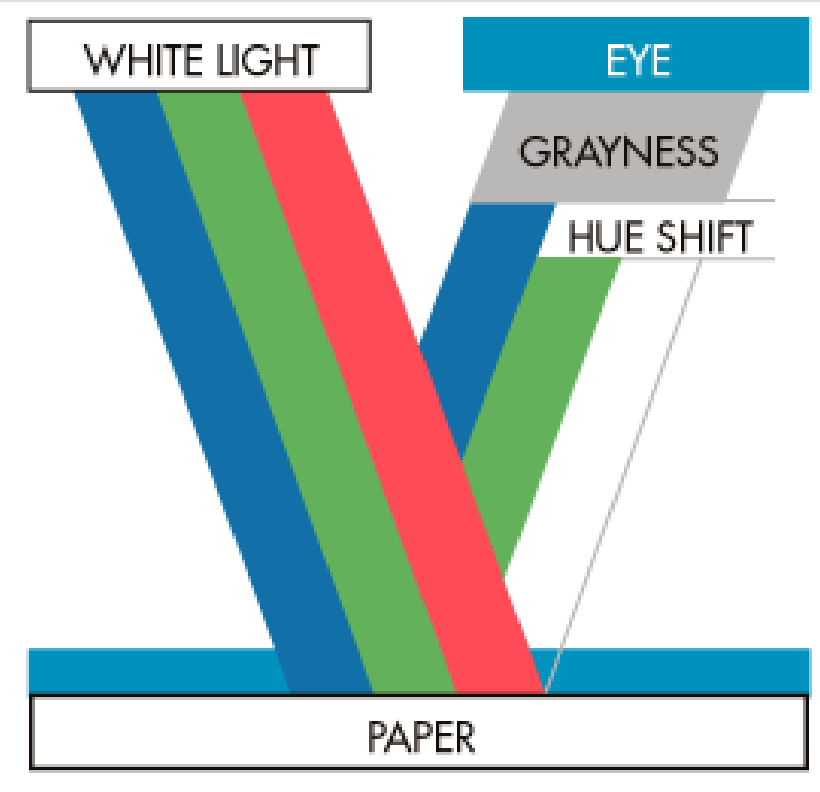
Process Color Space: CMYK Mode

- Subtractive color + ***black ink*** is how we print images—we call this the ***process color space***
- As previously mentioned, the normal printing process utilizing pigments (inks) represents full-color images as CMYK
- Pigments absorb light and subtract part of the visible spectrum before reflecting the remaining wavelengths

Color Properties of Cyan



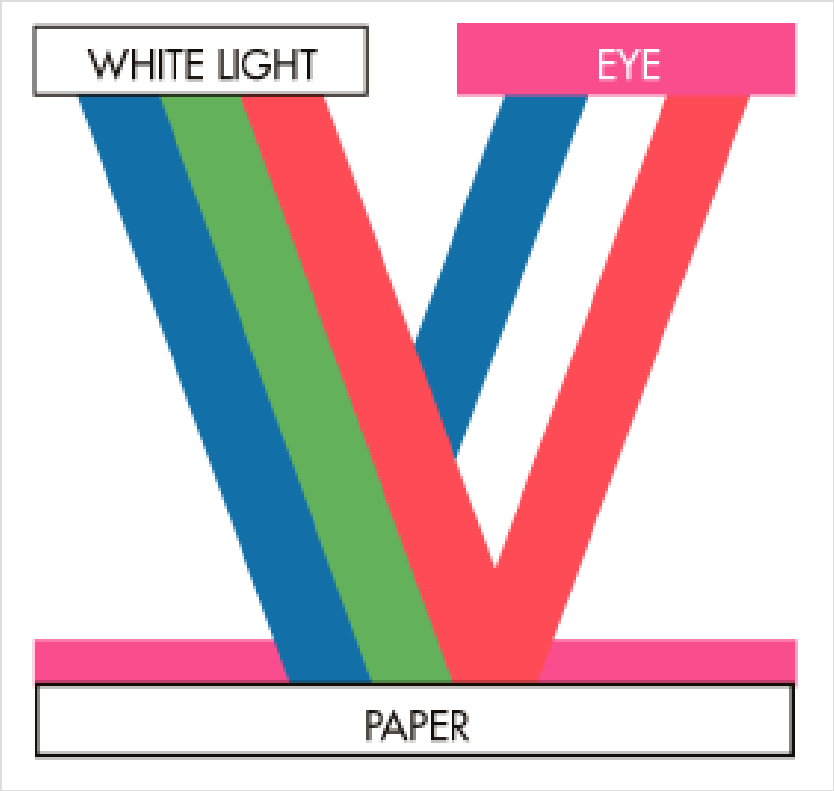
Ideal Cyan Ink



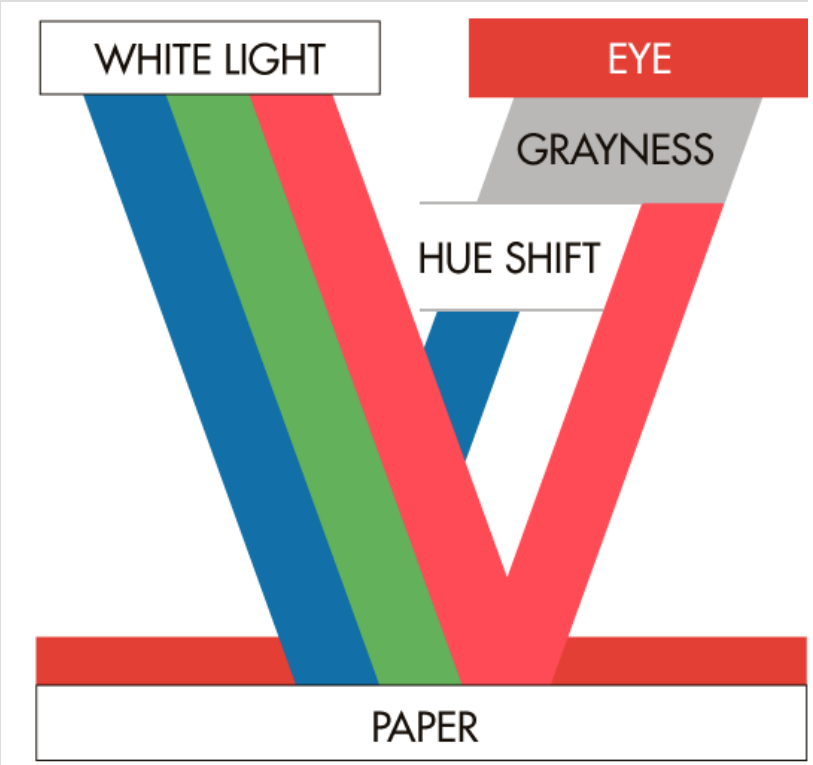
Typical Cyan Ink

A typical cyan ink exhibits unequal green and blue absorptions. Compared to the ideal cyan, this ink appears both more gray and more blue.

Color Properties of Magenta



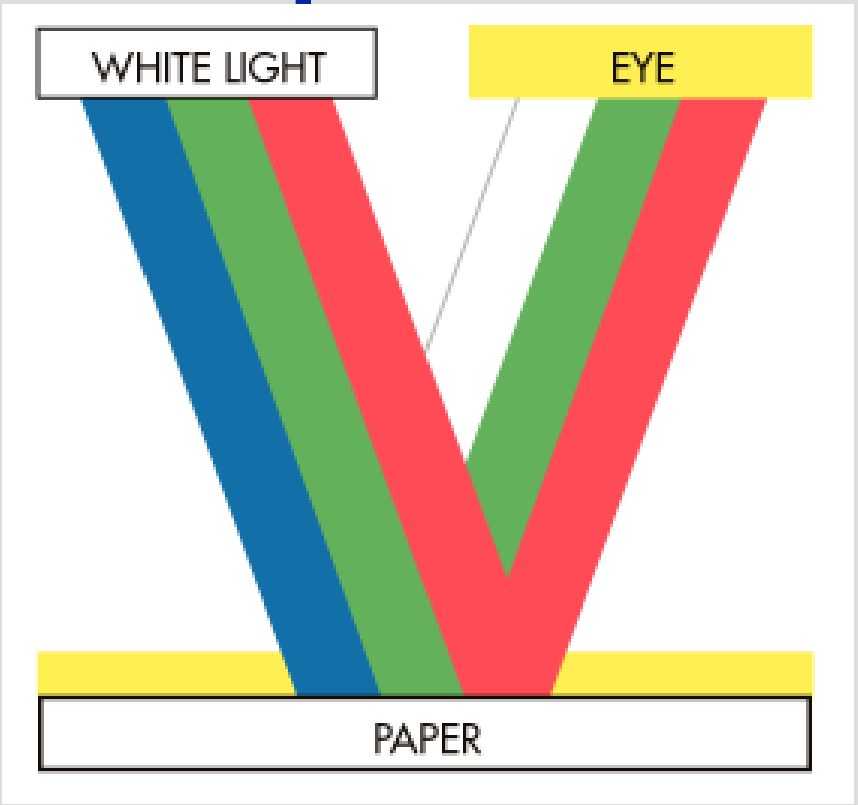
Ideal Magenta Ink



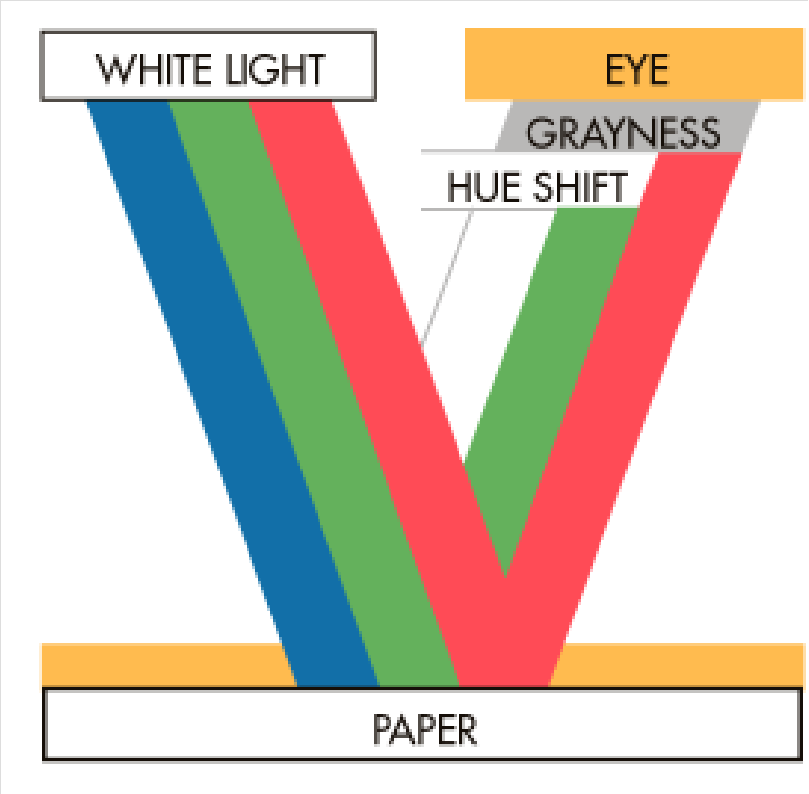
Typical Magenta Ink

A typical magenta ink exhibits unequal red and blue absorptions. Compared to the ideal magenta, this ink appears both more gray and more red.

Color Properties of Yellow



Ideal Yellow Ink



Typical Yellow Ink

A typical yellow ink exhibits unequal green and red absorptions. Compared to the ideal yellow, this ink appears both more gray and more red.

The Original = Photographs

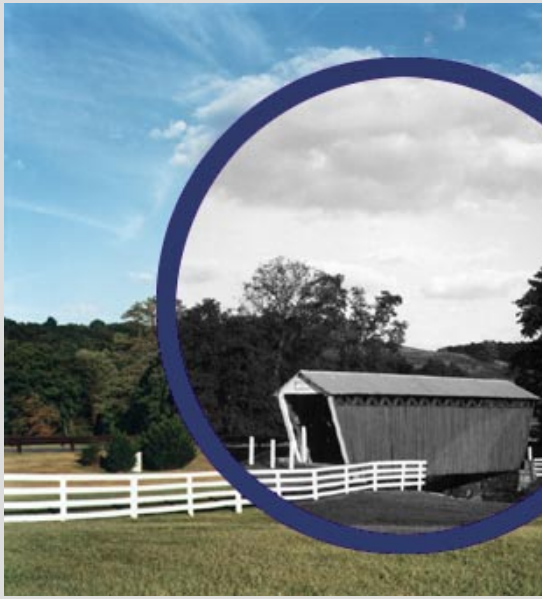
- Photographs contain cyan, magenta, and yellow dye
  - *There is no black dye in a photograph*
- Photographs are often referred to as continuous-tone images
- To reproduce a color photograph in the printing system, the cyan, magenta, and yellow continuous-tone information must be individually analyzed and recorded

Key Points of Color Separation

- Scanned image data is recorded as red, green, or blue gray values

The cyan information is extracted through the red filter

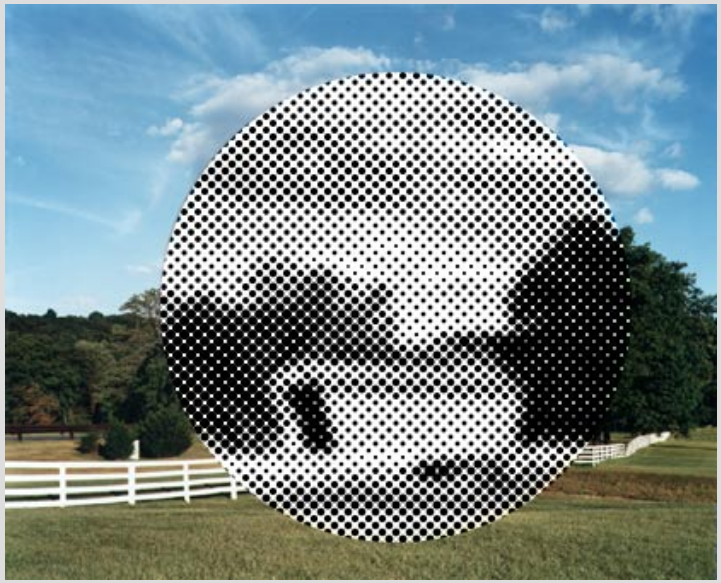
The magenta information is extracted through the green filter



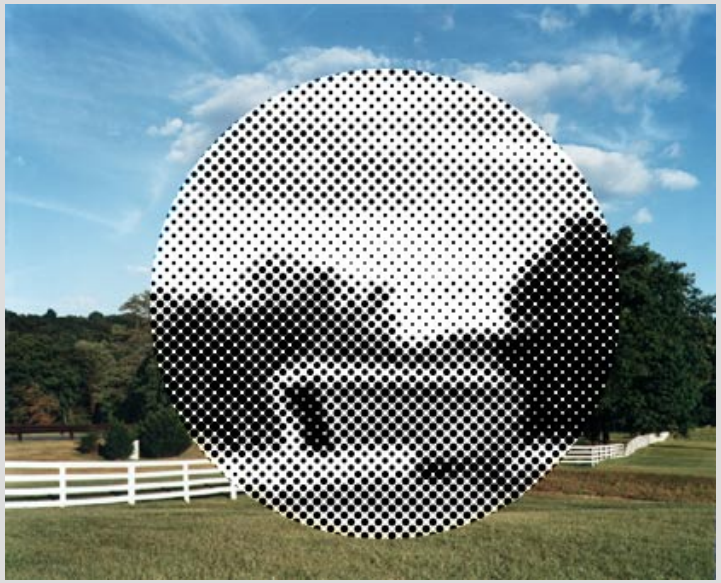
The yellow informat is extracted throug the blue filter

Key Points of Color Separation

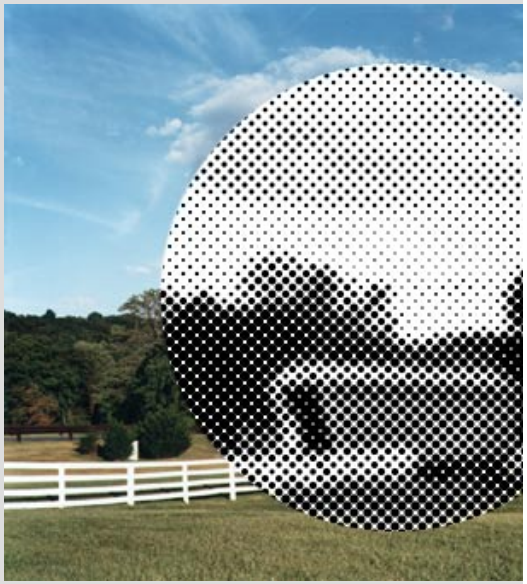
- These RGB gray values from 0 to 255 are converted to equivalent cyan, magenta, yellow, and black halftone dot values



Cyan separation



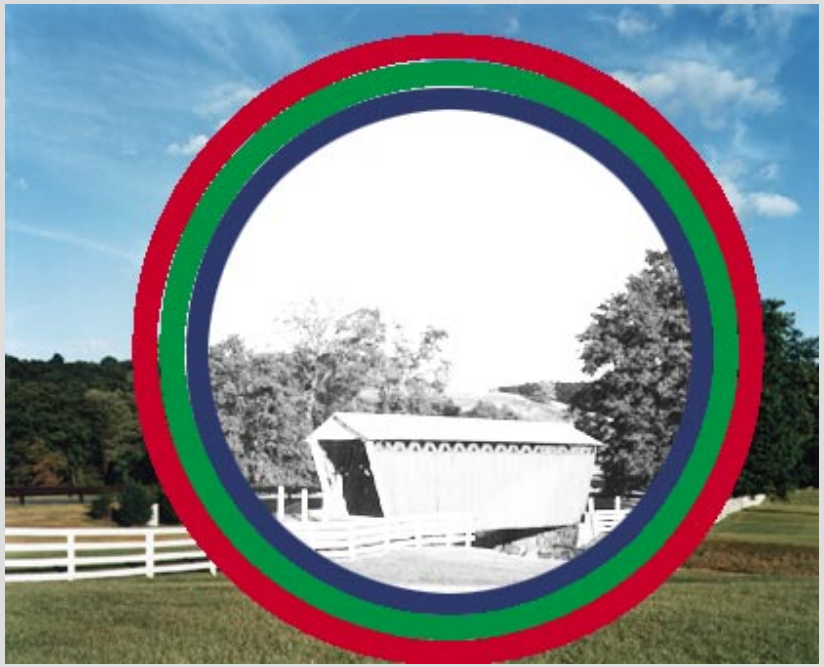
Magenta separation

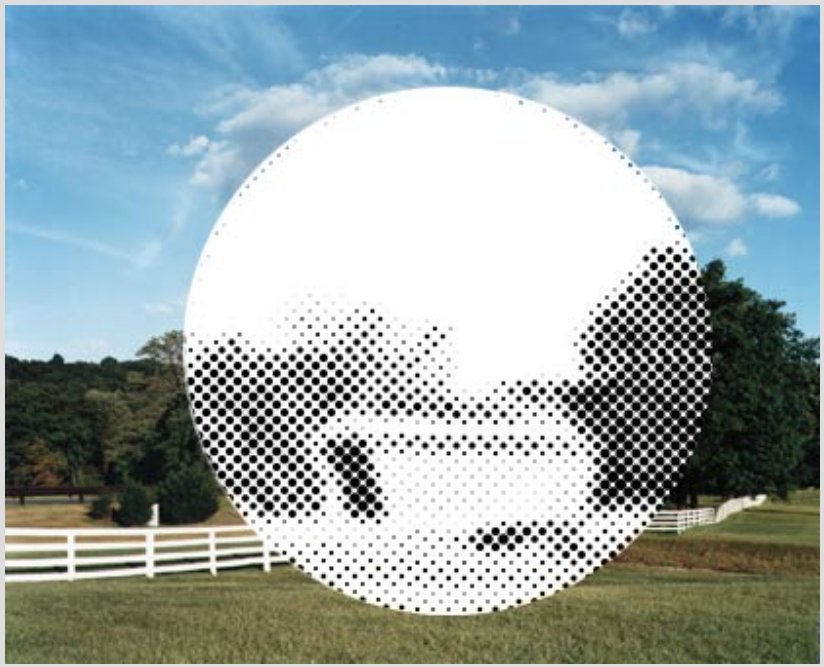


Yellow separation

Key Points of Color Separation

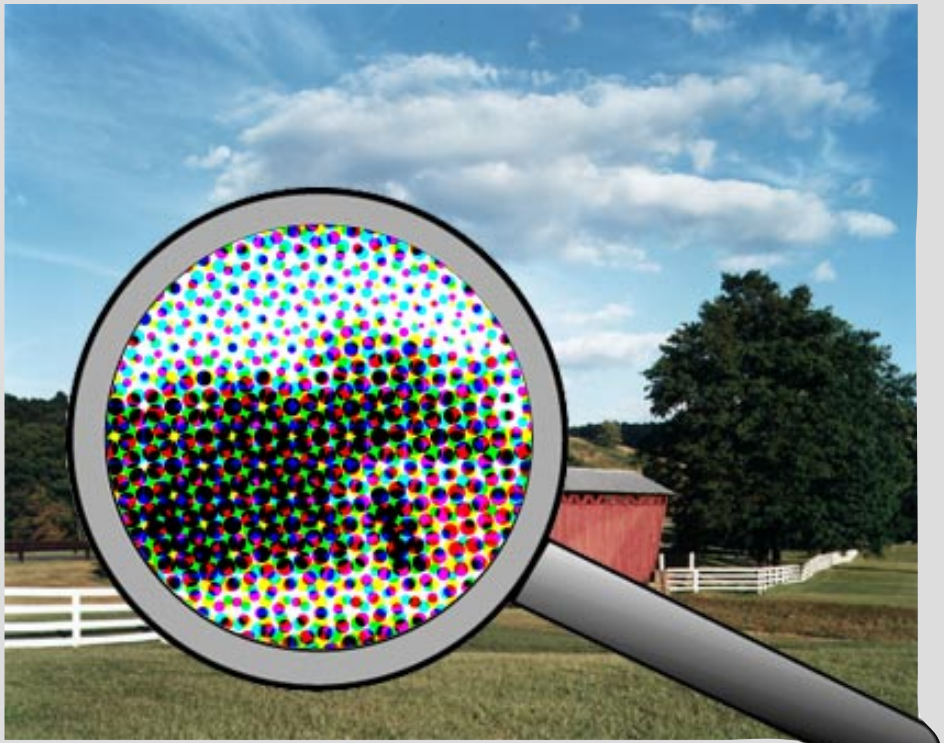
- The information for the black separation is calculated through the red, green, and blue filters
  - *When equal red, green, and blue signals are read through each of the filters, a black dot is*





Key Points of Color Separation

- When these dots values are printed at high resolution, the printed reproduction will appear as continuous tone
  - *As seen from a normal viewing distance*



Hi-Tech Color Printing?

- Even though we have digital technology, it doesn't mean we can reproduce more colors
- Ink and paper dictates the number of colors that can be reproduced on press
- Although today's printing presses and digital proofing devices can produce a large number of colors, they can never produce as many colors as the scanner is capable of capturing

Why Not Print with Additive Color?

- Why can't we print with red, green, and blue (instead of cyan, magenta, and yellow)?
  - *Green ink filters out red and blue light*
    - Subtracts 2/3 of the light's primaries
  - *Blue ink filters out red and green light*
    - Subtracts 2/3 of the light's primaries
  - *Red ink filters out green and blue light*
    - Subtracts 2/3 of the light's primaries
- Combining any two of those colors would create black—and of course, that's no good!

Color Is Dependent On ...

- 1. Light
  - *5000 Kelvin*
- 2. Object
  - *Absorption and reflection characteristics*
- 3. Sensor
  - *Eye*

Communicating Color

- Communicating the phenomenon we call color is difficult
- We sometimes use vague, crazy terms to describe color:
  - *Flat; muddy; needs more snap; too warm; too cold; needs more pop; needs to jump off the page*
- No buttons exist on scanners, within software, or on printing presses that are labeled with these terms!

Color Viewing Conditions

- Color proofing works when it is repeatable and consistent
  - *We can attempt to improve color communication by reducing variables through benchmarks*
- One important method for assuring color consistency is to agree on standard lighting conditions for viewing color proofs and press sheets
- Fortunately, this standard has already been established...

Color Viewing Specifications

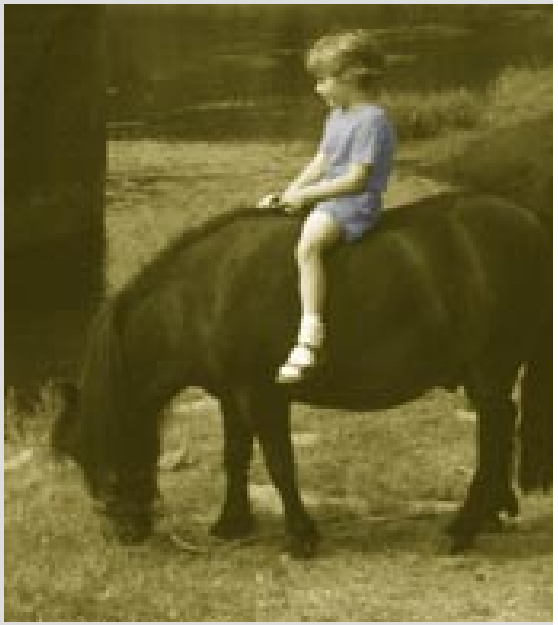
- In North America, we use the American National Standards Institute (ANSI) viewing conditions:
  - *5000 Kelvin lights*
  - *A viewing booth (surround) painted with Munsell N8 gray paint*

Courtesy of GTI
(Graphic Technology Incorporated)

The Effect of the Surround

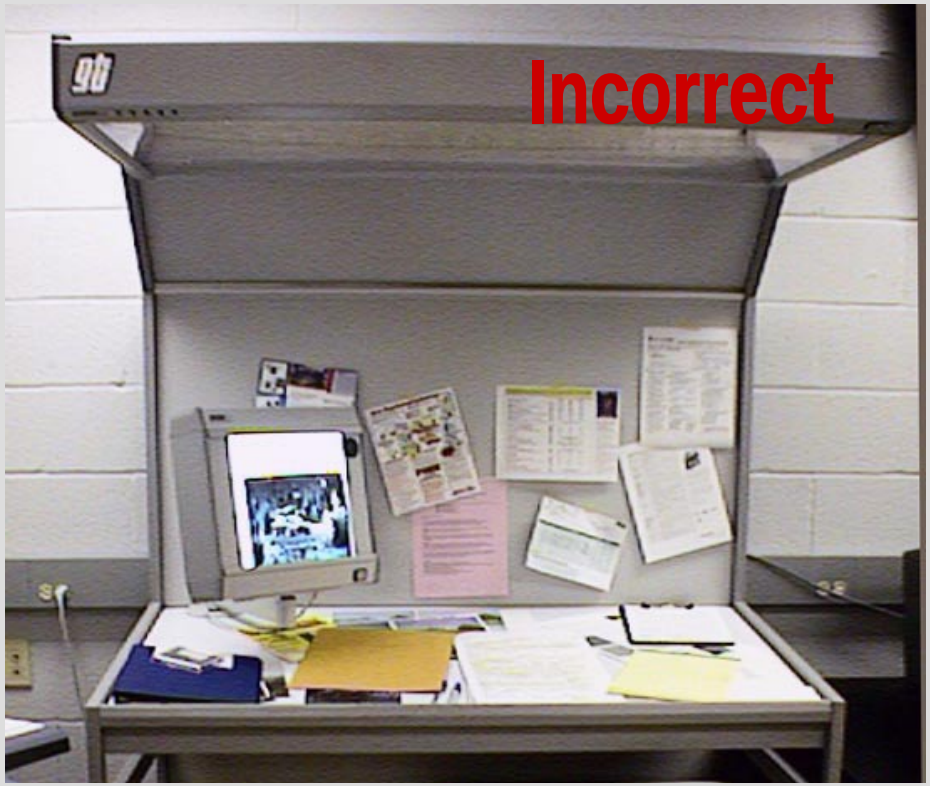
- Viewing conditions are important because the color that surrounds an image affects our perception of the image's color!

Black-Cyan Duotone **Black-Mag Duotone** **Black-Yellow Duoto**



The Effect of the Surround

- Viewing booths should be free of distractions that could influence color perception

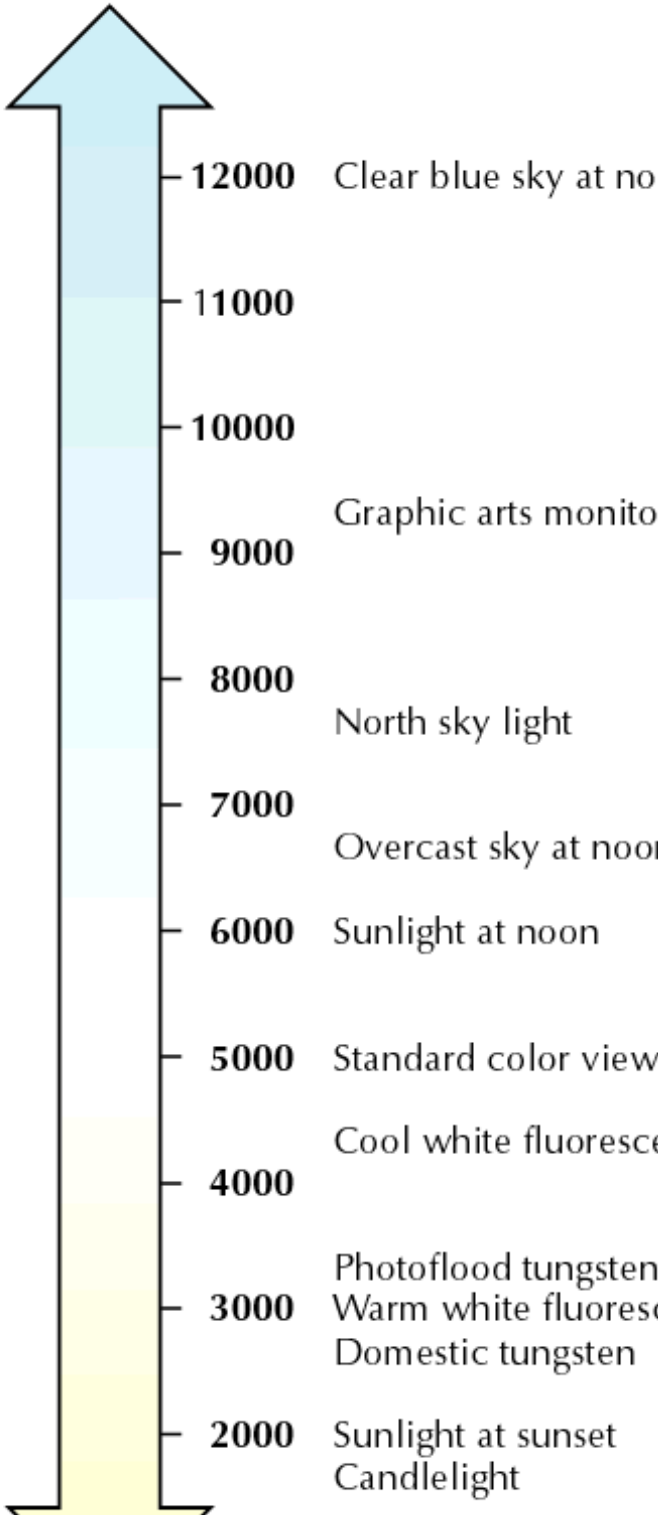


The Effect of Changes in Lighting

- The temperature of the light source is extremely important in determining what color is seen by the viewer
- Light temperature determines the relative balance of red, green, and blue spectrum radiation within the light itself

Color Temperature

- We use 5000 Kelvin (also called D50) because it contains an even mix of red, green, and blue wavelengths



The Effect of Changes in Lighting

- The same proof will look very different under different lighting conditions

Fluorescent illumination 7500 K

Tungsten illumination 2800 K

5000 K Illumination

The Effect of Changes in Lighting

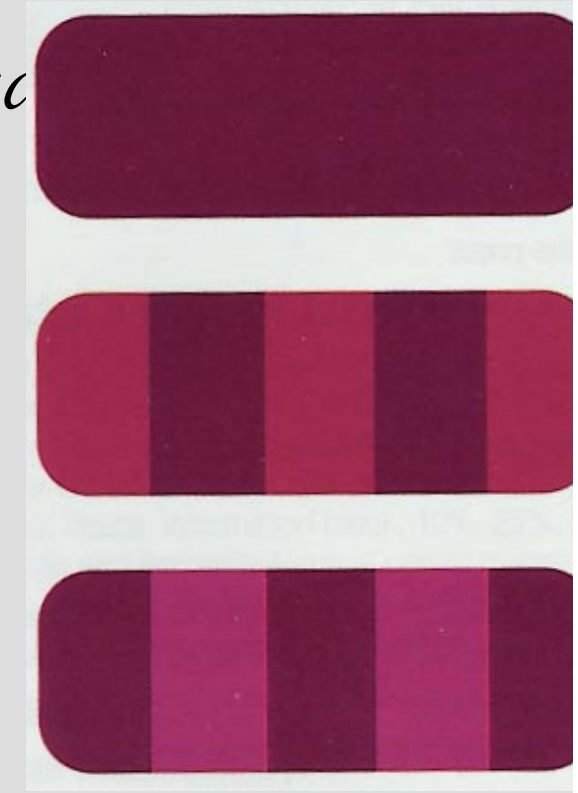
- ***Metamerism:*** When two colors appear identical under one lighting condition, but appear different under another
- This effect occurs because two items that are the same color can be made from very different materials
- Each substance has different light absorption characteristics and is affected by changes in light source differently

Who Cares about Metamerism?

- You should! Metamerism can be the cause of problems with customer expectations
  - *Your client may have approved the color proof when compared to the original photo in a viewing booth*
  - *However, under department store lighting the colors no longer appear to match*
- Even prepress sheets and color proofs suffer from the effects of metamerism
  - *Ink pigments have different light absorbing characteristics than the colorants and materials in offpress color proofs*

Judging Your Viewing Conditions

- A popular (and inexpensive) tool for evaluating lighting conditions is the ***RHEM light indicator***
  - *Attach to every proof to indicate whether lighting conforms to 5000 K*
  - *Solid color indicates proper light source*
  - *Banding indicates color temperature is not 5000° K*



Color Measurement

- Although color perception is subjective, color reflection can be measured!
  - *Spectrophotometers measure reflectance throughout the visible spectrum*

Thanks for listening!