

## Basic Color Mixing Rules

### INTRODUCTION

Vision is arguably our most compelling sense. (“Seeing is believing.”) Although we can easily interpret colorless images (black-and-white photographs, paths through the woods on a moonlit night, etc.), we tend to find images in color far more interesting and informative.

In one important way, however, our color vision is impoverished relative to other senses. When we taste a solution of sugar and salt, we experience both sensations (sweet and salty), and not some “average.” When we observe mixtures of paints or lights of different colors, however, we experience a color different from the constituent colors. Often, more than one combination of pigments or lights can produce a single color sensation.

### *Some useful concepts*

**Hue:** Basic color (e.g., red, orange, yellow, etc.).

**Brightness:** The overall intensity of the light from dark to dazzling, or the total amount of light.

**Saturation:** The purity of a color. The absence of other colors of the spectrum that would combine to make white (or gray), therefore the degree of difference of a hue from gray (or white) of the same brightness. Red is saturated, pink is unsaturated. (Notice that this is unrelated to brightness.)

**Additive color mixing:** Mixing lights of different colors so you see them in a single spot simultaneously. The lights are *added* together.

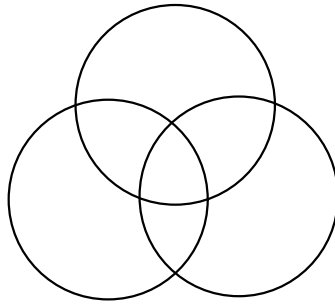
**Subtractive color mixing:** Combining the filters through which one light shines (or the pigments off which one light reflects). Each filter *subtracts* part of the light.

In this exercise, we will consider only eight colors: red, green, blue, cyan, magenta, yellow, white, and black. Our filters are named for the color we see when we shine white light through them.

Do the exercises on these sheets as best you can; test your hypotheses at the beginning of class next period.

## ADDITIVE COLOR MIXING WITH SLIDE PROJECTORS

Try to come up with a set of rules for mixing red, green, and blue light, in pairs and all together. Recall what we did in class by using filters and shining the lights onto a white surface, overlapping them as appropriate. Fill out the table below with the algebra of additive color mixing.



$$\begin{array}{r} R + G = \\ \hline R + B = \\ \hline G + B = \\ \hline R + G + B = \end{array}$$

Based on these rules, predict what would happen if you mixed the following lights. We have done these tests in class; if you wish to repeat them, the projectors will be available in class for you.

	Prediction	Empirical result
Y + B =		
M + G =		
C + R =		

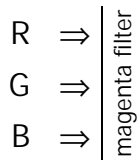
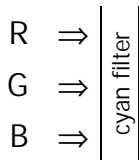
- ✓ **Be sure you are clear on why this is called additive mixing, and why R, G, and B are the additive primary colors, and why C, Y, and M are secondary colors.**

## SUBTRACTIVE COLOR MIXING WITH THE OVERHEAD PROJECTOR

Solve these problems by algebra, then propose ways to test the truth of them by clever placement of filters on the overhead projector. (Which colors can pass through the C, Y, or M filters, and which cannot?)

$$\begin{array}{r}
 W - R = \quad + \quad = \\
 \hline
 W - G = \quad + \quad = \\
 \hline
 W - B = \quad + \quad =
 \end{array}$$

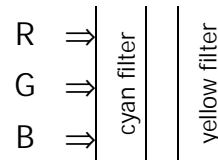
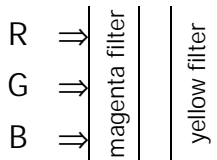
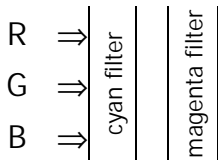
Draw diagrams showing which lights pass through each filter:



Solve these problems with algebra:

$$\begin{array}{r}
 W - R - G = \\
 \hline
 W - G - B = \\
 \hline
 W - R - B =
 \end{array}$$

Draw diagrams to show how overlapping filters work:



If you take all the colors away from white light, you have no more light, also known as black (abbreviated K). How might you demonstrate this with clever placement of filters?

$$W - R - G - B = K$$

Solve these problems by algebra. How would you demonstrate each statement with clever placement of filters?

$$\begin{array}{r} K = W - R - \\ \hline K = W - G - \\ \hline K = W - B - \end{array}$$

- ✓ **Be sure you are clear on why this is called subtractive mixing, why C, Y, and M are the subtractive primary colors, and why you need to refer to them by what they take away from the light.**