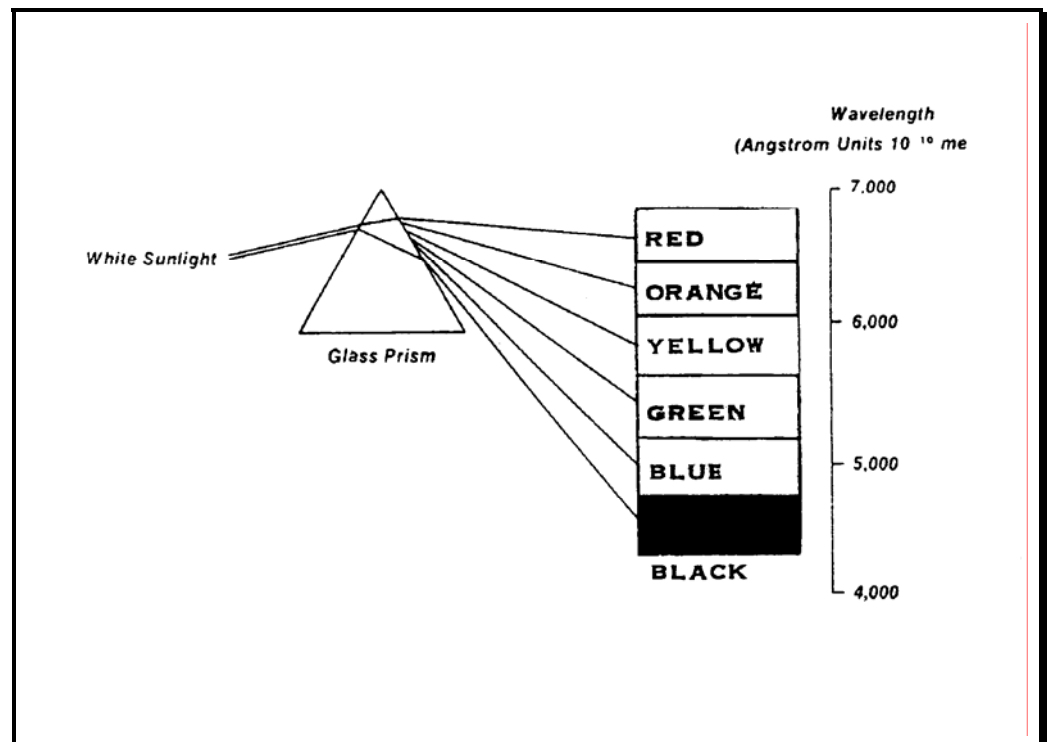


## Competencies

- The color spectrum
- How the eye perceives color
- The attributes of color--Hue, Saturation and Value
- Additive and subtractive mixing
- Primary colors of light and pigment
- Influences on color perception
- Subjective color perception

## Defining Color

Light is caused by certain waves of radiant energy. The electromagnetic spectrum contains waves as long as 3,100 miles and as short as one ten-thousandth of an angstrom unit (254 million angstrom units = 1 inch). Waves that produce a sensation our eyes recognize as light ranges from 3,800 to 7,600 angstrom units. The shorter waves produce a violet color while the longer units produce a red range. Below the visible range are ultra violet rays that tan your skin. The infrared rays above the visible red waves are useful in heat therapy.



When your eye sees the entire spectrum, the sensation is white light. If only specific wavelengths are seen, then a specific color is recognized. Usually we see colors as reflected light. The reflecting material or object acts a filter and absorbs all but the specific wavelength that is reflected.

Light must be present for your eye to perceive color. When the illumination level is reduced, the object begins to look black.

## Color Perception

The eye receives light of a certain wavelength or mixture of wavelength that is then interpreted as a certain color. In other words, the object reflects a certain color that we can see. When light strikes a colored object, it is reflected through a double convex lens into the eye. In front of the lens is an adjustable iris that enlarges and contracts proportionally to the intensity of the reflected light. The interior of the eyeball is the retina and is made up of two types of sensing cells. The entire surface of the retina is covers with rods. They are very sensitive to the varying light intensities and allow us to see in low light levels. They are insensitive to color, however. The eye receives color information through cells called cones. They are clustered near the center of the retina.

The eye cannot quickly adjust for any sudden change in intensity or color. The iris adjusts very quickly, but the retina must be regenerated. It takes about 60 to 90 seconds to adjust for an abrupt intensity change, while a color change may take as long as five minutes.

## Color Attributes

A specific color can be described as having three properties or attributes - hue, saturation, and value.

### Hue

The hue describes the color itself. Pure hues are those with a specific position in the color spectrum. Most colors we see are combinations of several wavelengths. Using a Vectorscope, Phase Angle indicates hue and is measured on the parameter of the screen.

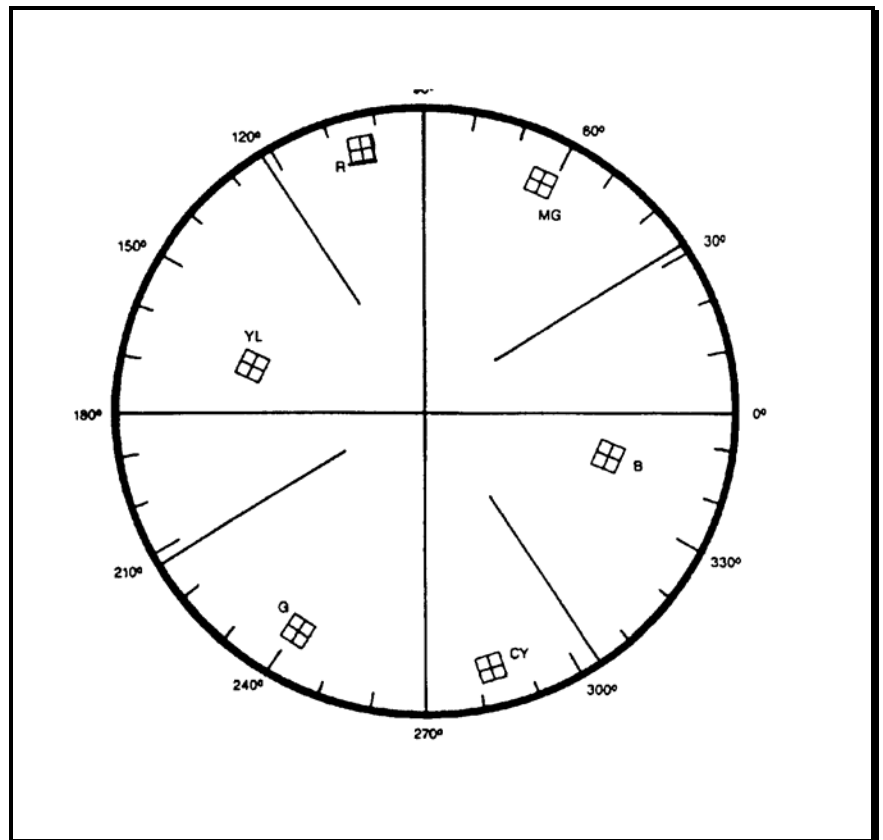
### Saturation

Saturation or Chroma refers to the richness or color strength of the reflected light. Less saturated colors appear pale while fully saturated colors appear vibrant. On the Vectorscope, Chroma amplitude is shows color saturation, measured outward from the circle's center (0-100).

## Value

The third attribute of color is its value or brightness. Value indicates how light or dark a color appears in black-and-white photograph. The lighter values, nearer white, are known as tints and the darker values, approaching black, are referred to as shades. A Waveform monitor indicates the value of a color (0-100).

An early problem with using color in black-and-white television lighting was selecting colors with different values.



## ROSCOLUX FILTERS, IN PHASE ANGLE SEQUENCE, 0° THROUGH 360°

ROSCOLUX NO.	PHASE	CHROMA	LUMINANCE	ROSCOLUX NO.	PHASE	CHROMA	LUMINANCE	ROSCOLUX NO.	PHASE	CHROMA	LUMINANCE
97	0	0	70	124	100	55	21	122	258	37	29
100	0	0	70	120	101	60	23	126	259	40	29
101	0	0	82	30	106	50	65	75	262	77	53
102	0	0	63	40	107	60	58	89	264	73	50
104	0	0	74	1	108	45	68	94	276	66	45
105	0	0	38	127	110	77	33	92	278	63	55
106	0	0	54	22	112	88	42	93	286	38	52
113	0	0	69	5	114	21	85	95	290	50	35
114	0	0	88	123	114	75	40	73	291	58	54
115	0	0	44	4	115	35	77	66	292	33	80
54	4	17	72	19	115	88	37	72	294	70	60
57	8	30	49	3	120	40	74	70	298	42	64
85	9	30	20	23	120	82	50	71	298	58	51
56	15	46	30	98	120	5	50	69	303	70	42
58	22	40	35	99	120	20	57	61	304	25	78
51	32	16	72	111	120	4	33	76	304	40	32
52	32	24	60	17	123	50	69	107	305	7	50
59	33	34	16	2	125	26	80	62	306	30	62
47	37	25	39	18	125	54	69	63	306	30	76
48	60	40	43	21	128	78	58	67	310	50	53
49	64	50	24	16	135	42	75	108	310	21	33
37	74	25	84	20	138	72	64	109	310	11	57
44	76	50	57	9	140	38	80	65	312	50	50
43	80	62	50	8	145	23	85	60	315	23	70
38	85	21	73	15	145	72	70	64	316	41	53
36	86	40	70	13	147	40	81	68	320	50	39
34	90	42	68	14	152	70	73	77	324	40	33
35	90	22	80	11	157	53	80	81	326	42	40
45	90	51	37	103	160	7	61	80	334	43	31
46	91	71	25	116	160	3	40	79	336	50	33
33	92	25	80	12	170	70	78	78	337	35	43
42	92	75	29	10	172	78	81	74	340	46	20
31	96	41	69	7	178	21	91	121	341	45	30
41	97	84	43	6	180	18	90	55	342	22	63
24	98	78	38	96	180	30	87	125	349	40	25
26	98	75	27	87	210	18	86	53	350	12	78
32	98	60	55	91	210	10	18	82	354	37	29
25	100	82	31	88	220	27	80	84	355	30	43
27	100	48	21	86	226	41	60	83	358	44	23
50	100	40	40	90	258	41	30				

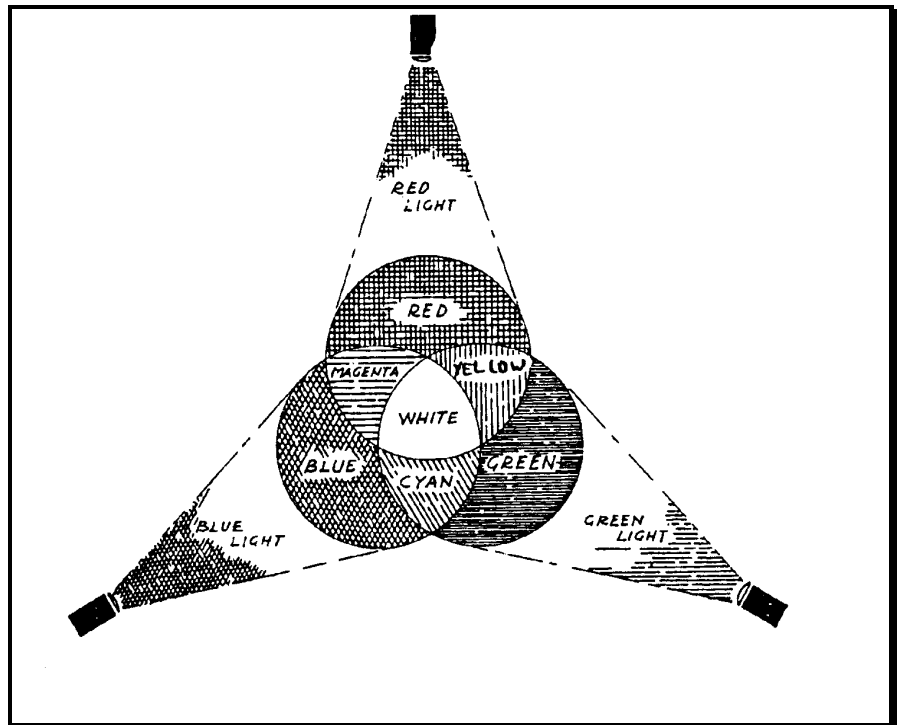
**Note:** Readings shown on these pages are the result of tests performed with the following equipment: Tektronix 529 Waveform Monitor, Tektronix 520 NTSC Vectorscope, Ampex CDL Switcher and Marconi MK8B Camera.

## Color Mixing

Mixing varies color. The two methods are Additive Mixing and Subtractive Mixing. This refers adding various wavelengths or blocking (subtracting) unwanted wavelengths. In additive color mixing, we add various hues of light to produce a variety of color sensations that are reflected to the eye. In subtractive mixing, we filter out or subtract all the Hues (wavelengths) that are not needed. Placing a filter in front of a light source is subtractive mixing by filtering out all hues except the color of the filter. Using pigment (painting) is the most common use of subtractive mixing. As various hues of pigment are mixed together, they tend to absorb all the hues and produce black.

## Primary Colors

All waves in the visible spectrum together form white light. It is not necessary to use every single wavelength to create this result. White light can be produced effectively by mixing, in the proper portions, red, green, and blue light. Red, green, and blue therefore are considered the primary colors of light, for no mixture of other colors will produce these at full purity; but together, in varying proportions, they can produce any color. Color television works on this principle. Three pickup devices, each with either red, green, or blue filters separate the image into three distinct pictures. Activating corresponding red, green, or blue phosphorus dots or stripes on the face of the picture tube reproduces the image. Your eyes then blend these three colors to create the natural color picture.



When using paint (pigment), the three primary colors change. Red and blue are still primary, but yellow becomes the third primary color. In detailed subtractive color mixing such as color printing, Cyan, Magenta, and Yellow are used as primary colors.

## Color Relationships

In addition to the three primary colors of light, secondary colors can be described. Yellow falls between red and green; cyan falls between green and blue, and magenta falls between blue and red. As the additive mixing of colored light tends to move toward white, the secondary colors are lighter in value than their primary counterparts on the color wheel. Those colors opposite each other on the color wheel are called complementary colors.

## Interaction Between Light and Pigment

Light mixes additively, however, when an object is painted a specific color, the colored light mixes with the colored object subtractively. A red apple does not turn yellow under a green light as it would if the colors were mixed additively, but changes, rather, into a muddy black because the green light acts a filter, blocking the red reflection from the apple. This same effect happens when green is used to light a performer because there is so much red in most skin tones.

A color changes depending on what surface it is painted on. If the surface is very dense and reflective, such as glossy enamel, the color will look more vivid than when used on a highly absorbent surface, such as velvet.

A color is greatly influenced by the color, or colors, which surround it. Complementary colors provide the most contrast. Those colors next to each other on the color wheel are said to be in harmony and provide little contrast.

## Subjective Color Perception

Different hues tend to provoke different feelings or understandings to the individual.

### Temperature

It is generally assumed that red is warm and blue is cold. There is a tendency to consider all colors of the red (longer wavelength) end of the spectrum warm and all colors of the blue (shorter wavelength) end cold. This generalization is not completely accurate, however. There are certain blues that we experience as warm and some reds that appear rather cool. By using cold or warm colors, we can actually manipulate a person's temperature perception.

### Space, Time and Weight

Warm colors tend to enlarge space and make it appear closer while cooler colors tend to shrink the object and make it appear further away. Reds seem to expand time while blue contracts it. Warm colored objects appear to be heavier while cooler colored objects appear lighter.

### Energy

In setting a mood, warm colors that are bright and highly saturated tend to increase the energy level of the audience. The opposite is true for cold colors with low chroma and saturation.

### Emotion

Most emotional response to color is conditioned by a lifetime of reaction to colors in nature and under natural light. We have come to expect certain objects to have a certain color. Food is a good example of this conditioning. We are also influenced by centuries of social and religious conventions. We react to symbolism in color such as traffic lights or road signs.

In general, the following hues have traditionally produced the listed emotions:

- RED - Active, passionate, full of inner warmth, fiery, strong, forceful.
- GREEN - Tranquillity, compassion, nature in the spring and summer.
- BLUE - Passive, cold, receding, deep, and icy.
- YELLOW - Radiant, light giving, golden, saintly, virginal.
- ORANGE - Festive, earthy, nature in the fall.
- VIOLET - Royal, piety, shadows, terror, chaos.