



# Defining **COLOR**

Systems for precise color validation

Munsell Color  
x-rite

**NEURTEK**  
i n s t r u m e n t s

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## The Value of Color

**COLOR** is a difference maker.

**COLOR** has the power to attract. To engage. To embrace.

**COLOR** inspires. Enlightens. Energizes.

Color brings vitality to everything we do. Whether developing a corporate identity, a brand, a new product, color has the power to create an impression that separates your image or product from everyone else's. It is, for many, the defining element of your product's personality.

Defining your color and ensuring its accuracy every time it appears is fundamental to long-term success. X-Rite is a global leader in quantitative color measurement and visual analysis. We pioneer innovative solutions that are scalable from a single location to a global, multi-facility enterprise. The results are improvements in productivity, time-to-market, and profitability.

Our Munsell Color enhances your ability to standardize color specification, viewing and measurement — tools that simplify color communication and minimize guesswork and misunderstanding.

**We're ready to help you make a difference with your color program.**

# Munsell: The Universal Language of Color

Everyone perceives color differently. But there are ways to ensure that everyone sees the color you want them to see. The Munsell Color Order System is an accepted method, worldwide, for precise color specification.

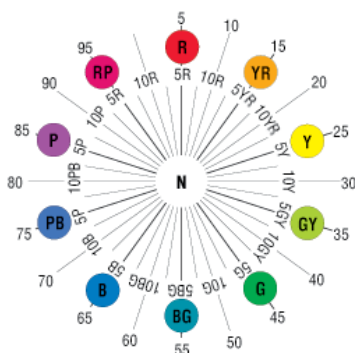
## The Munsell Color Order System

At the beginning of the 20th century, Professor Albert H. Munsell brought clarity to color communication by establishing an orderly system for accurately identifying every color that exists. Munsell based his system on what he defined as “perceived equidistance,” the human visual system’s perception of color.

The Munsell Color Order System is a three-dimensional model based on the premise that each color has three qualities or attributes: hue, value and chroma. Munsell established numerical scales with visually uniform steps for each of these attributes. In Munsell notation, each color has a logical relationship to all other colors. This leads to endless creative possibilities in color choices, as well as the ability to precisely communicate these choices.

## Hue

Hue (H) is the actual “color” that follows a natural order of red (R), yellow (Y), green (G), blue (B) and purple (P); designated principle hues. Between each were intermediate hues yellow-red (YR), green-yellow (GY), blue-green (BG), purple-blue (PB) and red-purple (RP). Arranged in an equally divided circle, these colors form the Munsell Hue Circle.



### Munsell Hue Circle

Hue	Symbol	Hue	Symbol
Red	R	Blue-Green	BG
Yellow-Red	YR	Blue	B
Yellow	Y	Purple-Blue	PB
Green-Yellow	GY	Purple	P
Green	G	Red-Purple	RP

### Value

Value (V) indicates the lightness of a color. The scale of value ranges from 0 for pure black to 10 for pure white. Black, white and the grays between them are called "neutral colors." They have no hue. Colors that have a hue are called "chromatic colors." The value scale applies to chromatic as well as neutral colors.



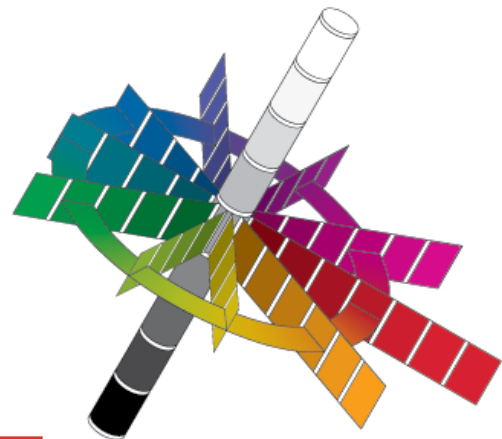
### Chroma

Chroma (C) is the degree of departure of a color from the neutral color of the same value. Colors of low chroma are sometimes called "weak," while those of high chroma are said to be "highly saturated," "strong" or "vivid." The chroma scale starts at zero, for neutral colors, but there is no arbitrary end to the scale. As new pigments have become available, Munsell color chips of higher chroma have been made for many hues and values. The chroma scale for normal reflecting materials extends beyond 20 in some cases. Fluorescent materials may have chromas as high as 30.

## How Munsell Color Notation Works

All colors are arranged three-dimensionally according to hue, value and chroma creating the Munsell Color Space. Each color has a specific Munsell color notation from which you can easily visualize the color. Using the Munsell nomenclature HV/C, our vivid red example would have the Munsell notation 5R 6/14. 5R is the hue (red), 6 is the value (moderately light), and a 14 chroma indicates a highly chromatic color.

When a finer division is needed for any of the attributes, decimals are used. For example, 5.3R 6.1/14.4. When the hues of the primary hue circle are used, the notation is written in the same way, for example 2B' 5/4. The notation for a neutral color is written: NV/. The chroma of a neutral color is zero, but it is customary to omit the zero in the notation. The notation N 1/ denotes a black, a very dark neutral, while N 9/ denotes a white, a very light neutral. This notation for a middle gray is N 5/.



### Munsell Color Space

Munsell hue, value and chroma can be varied independently so that all colors can be arranged according to the three attributes in a three-dimensional space. The neutral colors are placed along a vertical line, called the "neutral axis," with black at the bottom, white at the top, and all grays in between. The different hues are displayed at various angles around the neutral axis. The chroma scale is perpendicular to the axis, increasing outward. This three-dimensional arrangement of colors is called the "Munsell color space."

### Munsell Color Solid

All colors lie within a specific region of Munsell color space called the "Munsell color solid." Hue is limited to one turn around the circle. The scale of value is limited on the lower end by pure black, which is as dark as a color can be, and on the top by pure white, which is as light as a color can be. For a given value, there is a limit to the chroma that is possible, even with theoretically ideal coloring agents. Real coloring agents, with less than ideal characteristics, impose further limitations on physical representations of the color solid. The Munsell Color Order System itself is applicable to all possible colors. The highest chroma yellow colors have rather high values, while the highest chroma blue colors have lower values.



### An International Standard

The Munsell color order system is recognized internationally by the following standards:

- American National Standards Institute  
— ANSI Z138.2
- Japanese Industrial Standard for Color  
— JIS Z872
- German Standard Color System  
— DIN 6164
- Several British national standards

The Munsell Color Order System has been widely used in many fields of color science, most notably as a model of uniformity for colorimetric spaces and has, itself, been the subject of many scientific studies.

### Lightbooths



X-Rite's Macbeth Lighting solutions complement the Munsell Color Order System through technology that simulates standard daylight to more accurately render color. This technology is further refined to permit accurate color viewing under all phases of daylight, including filtered tungsten halogen daylight, horizon daylight, blended daylight, and patented 7-phosphor fluorescent daylight. Products also provide accurate nighttime performance for second and third shift color evaluations.



## Munsell Notation as Basis for Establishing Reliable Color Standards

Consistency is essential to every color specification process or program. Munsell Color allows you to produce the physical color standard or tool needed to validate your specific process. With a custom color standard it is possible for you to not only specify the color you want but to also determine the correct appearance aspects of that color for the proper reproduction.

Munsell will match the physical or numerical standard you provide or work with you to clarify your color program. Among the options for developing standards are:

### **QuickColor Standards**

For fast, economical color matching, QuickColor is a proof-free, quick custom color standard for interim, conceptual or seasonal applications. These include color standards that have a short life cycle - such as seasonal products - and preliminary color standards for new products during the design process. QuickColor standards are matched to the desired gloss level (8½" x 11") paint-on-paper.

### Custom Color Standards

When precise color matching is critical to your success, present these stable, reproducible color standards to suppliers and anyone else who needs to match your colors. Simply submit your sample or provide numeric data and we'll match the color and gloss and provide a proof for your approval. Each Custom Color Standard comes with a Munsell System notation. Color standards can be produced to match a variety of color and appearance characteristics including opaque, translucent, transparent, fluorescent, textured, pearlescent, and metallic. Custom Color Standards are matched to the desired gloss level (8½" x 11") for paint-on-paper.

### Color Control Panels

For precise color communication, specification, and visual evaluation, this option provides a physical standard for the communication and specification of color and appearance to your vendors and raw materials suppliers. They are available in variations of 3" x 5" formats or custom sizes.

- The single-color control panel represents the master standard or specific target color. It provides a reference for visual assessment or a target for color matching with an instrument-based color system.
- The two-step painted panel represents either of a min/max tolerance range for two colors or an appearance standard for a single color at two gloss levels. For visual assessment of products with wider tolerances, the three-step painted panel includes the target color plus two tolerance limits.

Each labeled panel is packaged in a light-proof envelope with the notation and data needed to ensure accurate color reproduction. Color control panels can be produced in a variety of painted substrates or textured surfaces. They are also available in a washable form for applications requiring a more durable, cleanable surface, such as food applications.





### Color Tolerance Sets

Used to improve color quality control among buyers and suppliers, these are ideal for multi-component products manufactured in different geographic locations. Designed to reduce time and materials and accelerate time-to-market, the tolerance sets provide a visual criteria for evaluating finished goods. The Color Tolerance Set shows the target color plus acceptable limits held in tolerance around the ideal or centroid color. You determine the tolerance limits and criteria for communicating the tolerances. The tolerance limits are all defined as being a Light, Dark, Red, Green, Blue or Yellow limit when compared to the target color. The different types of Color Tolerance Sets are defined by the number of limits that are incorporated into the Color Tolerance Set. So a seven-step Color Tolerance Set would have a target color plus a Light limit, Dark limit, Red limit, Green limit, Blue limit and Yellow limit.





**The Color Tolerance Sets are available in four configurations:**

- Three-Step = target + two limits
- Seven-Step = target + six limits
- Nine-Step = target + six limits + two gloss levels
- Ten-Step = target + six limits + three gloss levels



**Texture Paint-on-Paper Color Standards**

Accurately reproduce your color standards in a surface texture with an option that produces a texture profile as well as the color of your specific product. Spatter-painted standards are available in fine, medium or coarse textures.



With Munsell Color being a part of X-Rite, we have at our disposal the industry leading color measurement tools and solutions. This means that the production of the color standards are controlled accurately but we are also capable of communicating the color in proper numerical format in addition to the Munsell Notation for the industry that it is used in. The use of the Macbeth lighting products means that we can evaluate the color of the standards accurately and be assured that they will visually match.

# ColorChecker Systems for Ensuring Photorealistic Color Reproduction

A snow-capped mountain peak. An endless wilderness vista in autumn. A work of fine art as if the artist's hand has just touched the canvas. It is every visual artist's dream to capture the perfect image and make it come to life. And yet, the reality of ensuring accurate color reproduction is a significant challenge.

Munsell Color responds to this challenge with a suite of proven solutions that provide the freedom and the capability to reproduce vivid, natural images as they are meant to be seen.

## ColorChecker

The ColorChecker is a checkerboard array of 24 scientifically prepared colored squares in a wide range of colors. Many of these squares represent natural objects of special interest, such as human skin, foliage and blue sky. These squares are not only the same color as their counterparts, but also reflect light the same way in all parts of the visible spectrum. Because of this unique feature, the squares will match the colors of natural objects under any illumination and with any color reproduction process.

The ColorChecker provides a totally non-subjective standard of comparison to help determine the true color balance of any color rendition system. It provides the needed standard for comparing, measuring and analyzing differences in color reproduction in various processes, thereby avoiding costly mistakes.

Some of its applications include:

- Digital Photography: Check images, output, monitors
- Traditional Photography: Check films, lights, filters and paper
- Graphic Arts: Check any printing or proofing process
- Digital Imaging: Check scanners, monitors and proofing devices
- Cinematography, Television and Video: Check cameras, monitors, lights and film.





### Mini ColorChecker

The Mini ColorChecker, a smaller, pocket-sized version of the ColorChecker, just 3¼" x 2¼," for on-the-job convenience



### Digital ColorChecker SG

The Digital ColorChecker Semi Gloss (SG) is specifically designed for digital photography. It is used with digital camera profiling to ensure the consistency of captured images.

The system is designed to mirror all the colors you can see:

- 140 patches chosen specifically for their location in color space expand the color gamut and allow you to create profiles that capture the full capabilities of your digital camera and scanner.
- Includes standard ColorChecker chart colors. Many of these squares represent natural objects of special interest, such as human skin, foliage and blue sky. These squares are not only the same color as their counterparts, but also reflect light the same way in all parts of the visible spectrum.
- More skin-tone reference colors deliver greater accuracy and consistency over a wide variety of skin tones.
- Gray scale steps provide accurate control of camera balance and maintain a neutral aspect regardless of light source.
- Sturdy, standardized target size of 8½" x 11" (21.6 x 27.9 cm) easily fits into a full frame shot.

The Digital ColorChecker SG chart includes the highest quality color reference standards available. X-Rite and the Munsell Color manufacture products in conformance with the accreditation practices and procedures for ISO conformance. All production instrumentation and equipment is traceable to NIST.



### **ColorChecker White Balance, Gray Balance, and Gray Scale Products for Digital Photography**

The perceived color of white often changes based on ambient conditions. Outdoors it is perceived to be cooler, indoors it is perceived to be warmer, and under fluorescent light it is perceived to be greener. Even in a controlled studio environment, it is necessary to establishing an accurate custom white balance to ensure an accurate image from the start of each photo session.

Munsell ColorChecker White Balance and Gray Scale products are convenient tools that give photographers the information needed to adjust the digital camera's color sensitivity to exactly match the ambient lighting conditions; to, in effect, change what that the camera sees.

White Balance products are scientifically engineered to provide a precise uniform surface that is spectrally neutral (reflects equal amounts of red, blue and green) in all light conditions. The photographer can now have confidence that the camera's raw image is as close to real life as possible.

Gray Scale cards serve as an ideal first reference shot in a series to easily correct image color under most lighting conditions by balancing on the mid-tone gray value. For the studio photographer, the ColorChecker Gray Scale permits quick set-up of the proper studio lighting ratio between main and fill lights for capturing accurate color without a lot of after-the-fact manipulation. In addition, the ColorChecker Gray Scale provides reference values that can quickly be checked and used to adjust colors within most common photo processing software packages.

## White Balance, Gray Balance, and Gray Scale solutions enhance overall photo quality by providing:

- A precise, uniform surface that is spectrally neutral under all lighting conditions
- Assurance that the digital camera's raw image accurately portrays real life
- Reference values to check and adjust colors
- The ability to instantly correct color images by setting the mid-tone gray value
- Quick setup of proper studio lighting ration between main and fill lights

## ColorChecker White Balance and Gray Scale Products include:

### ColorChecker White Balance

- A full-size version of the white reference square used in the standard 24-patch ColorChecker
- ColorChecker Mini Gray Balance and Mini White Balance cards
- Pocket-size (4" x 7") versions of the 18% gray reference square and the white reference square used in the standard 24-patch ColorChecker

### ColorChecker Gray Scale

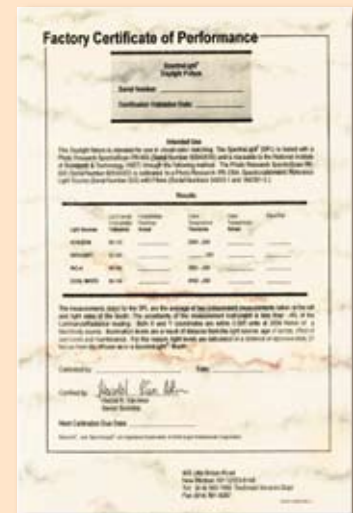
- A full-size version of the white, 18% gray and black reference square used in the standard 24-patch ColorChecker

### ColorChecker Mini Gray Scale card

- A pocket-size (3¼" x 2¼") version of the white, 18% gray and black reference square used in the standard 24-patch ColorChecker

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## Lighting audits/certification



X-Rite's Macbeth Lighting solutions provide opportunities to optimize viewing conditions and comply with major industry standards. X-Rite technicians and technology are employed to conduct lighting audits and introduce solutions that ensure consistent, accurate color viewing. This program extends to lighting system certification — from ensuring equipment meets ISO, ANSI and other standards to recalibrating equipment and instrumentation.



## Munsell Vision Tests for Effectively Evaluating Color Acuity

Getting the color right is as important as getting the right color, and it begins in-house with the people who communicate your color to your customers.

It is the ability to effectively and consistently see color that allows individuals to articulate the color information that needs to be communicated to manufacturing processes, assembly, packaging, promotion — all aspects of your operation. This means it is equally important to be able to certify that the individuals responsible for critical color evaluations can successfully discern and communicate color assessments. Munsell Color provides tools for assessing this capability.

### **Farnsworth-Munsell 100 Hue Test**

This easy-to-administer test is a highly effective method for measuring an individual's color vision. Used by governments and industry for over 40 years, the test is used to evaluate and rank color acuity. The test consists of four trays containing a total of 85 removable color reference caps (incremental hue variation) spanning the visible spectrum. Color vision aptitude is detected by the ability of the test subject to place the color caps in order of hue.



## Typical applications of this test include:

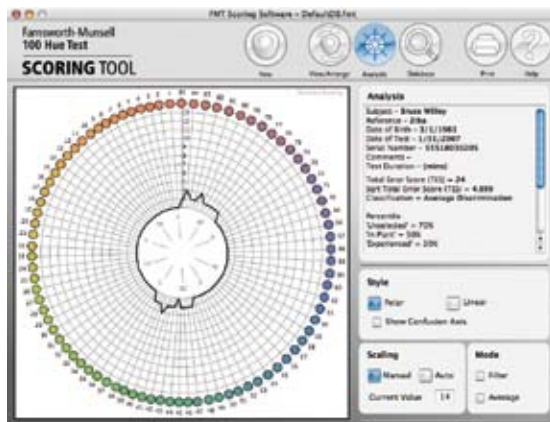
- Examination of inspectors of color goods, color graders and color matchers
- Testing for type and degree of color deficiency
- Analysis of color vision of in-house and field staff
- Selection of applicants for vocational training
- Design of color vision tests
- Measurement of effects of medical treatments
- Independent control for measuring the validity of other color vision tests

## FM 100 Hue Test Scoring Software

The Farnsworth-Munsell Hue Test Scoring Software expedites and simplifies scoring of the FM 100 Hue Test and provides a powerful set of analytical and administrative tools. Results can be saved, displayed in polar or linear format, and filtered or analyzed according to a variety of algorithms.

## Farnsworth-Munsell Dichotomous D-15 Test

An abridged version of the FM 100 Hue Test for screening color vision defects only. The D-15 Test is intended for the detection of color vision defects such as red-green and blue-yellow deficiencies as opposed to color acuity. The test consists of a reference cap and 15 removable chips of incremental hue variation.



## Munsell Color Books

Munsell Color books are as versatile as they are inspirational. Individual colors are available in 8" x 10" sheet format for use as reference samples and standards. They are ideal for establishing precise color standards between multiple sites and designers. They are a reliable tool for verifying color consistency between production runs.



# Munsell Reference Books Bring Order to Color Communication

Choosing the right color for your business or product is just the first step. Assuring that it communicates in a variety of single- and multi-dimensional formats is equally important. The only way to accomplish this is to have a full range of choices available.

You have them with Munsell Color. Munsell wrote the book on color... many books, in fact. More than just a collection of colors, Munsell Color books are the physical representation of the points within the Munsell Color Order System. They allow the user to specify any color within the spectrum, even if it does not appear in the book. And while Munsell books are designed to serve as color guides they can also be used for establishing communication standards. It is this flexibility that allows us to supply the color you need to give your product the look it deserves.

## Munsell Book of Color

The master atlas of Munsell Color, this book contains over 1,600 removable high-gloss color samples on 40 constant-hue pages. Additional pages of Munsell grays, supplementary accent colors and 37-step neutral value chart are also included. Individual colors may be purchased separately in 8½" x 11" full sheets.

## Matte Finish Collection

For projects that require colors without surface gloss, the Matte Finish Collection gives you over 1,300 permanently mounted matte color samples on 40 constant-hue pages. Additional 31-step neutral value chart is also included. Individual colors may be purchased separately in 8½" x 11" full sheets.





### Nearly Neutrals® Collection

This collection of over 1,100 pastel colors is ideal for projects that require neutral, subtle colors. The matte color samples are mounted on 20 constant hue pages plus one Nearly Whites® constant-value page. Individual colors may be purchased separately in 8½" x 11" full sheets.

### Munsell Sheets of Color

All of the colors displayed in any of the Munsell Books of Color can be purchased as an individual 8" x 10" sheet of color. These sheets are useful tools for developing standards and certified color samples.

### Government and Industry Standards

Munsell Color has been involved in the production of physical color communication and specification devices for over 70 years. Over this time we have developed solutions adopted by numerous government and industrial organizations, such as ANSI grays and safety standards, and NEMA and electric power industry standards.

### Color Coding Charts

A selection developed for color coding of wire and cable insulation and by Electronic Industries Association (EIA RS359-A) for use with electronics components. Includes ten 8½" x 11" color charts in a binder: red, orange, brown, yellow, green, blue, violet (purple), white, gray (slate) and black. Each chart defines the centroid (ideal) color and the permissible visual tolerances.

### Supplemental booklets are also available for the following:

- EIA color coding charts for the telecommunications and fiber optics industries
- EIA-TIA 598-A Aqua color coding chart
- EIA-TIA 598-B Rose color coding chart

### Plant Tissue Color Charts

A color guide for botanists, this collection of 17 Munsell Color Charts is designed to provide a means for the exact determination and permanent recording of the color of plant tissues. In particular, it aims to facilitate the diagnosis of adverse conditions responsible for the deterioration of plants and to serve as a stepping stone to soil and plant tissue analyses.

The color plant tissues reflect the influence of light, critical temperatures, and the chemical composition of the soil, especially when the soil is deficient in certain major or minor nutrient elements. Sometimes the color of plant tissue reveals the genetic origin of plants, effect of toxic substances, or the action of parasitic organisms. Charts provide scientists, students, and plant growers with information needed to respond to problems related to taxonomy, genetics, physiology, pathology, and plant nutrition.



### Soil Color Charts

Developed jointly by Munsell Color and the USDA Soil Conservation Service, these 9 charts are used to classify soil colors and judge rocks, hydric soils, archeological samples, and other natural products. Agronomists, biologists, archeologists, geologists, zoologists, and other scientists use these charts to document specimen colors. The charts include color name diagrams, soil structure diagrams, and masks. Individual replacement pages are available, as well as charts for semi-tropical soils, Australian soil, and Southeast Asia and glauconile soils. New edition washable charts for soil color classification are also available.



## USDA Food Standards

Munsell Color maintains an ongoing program for development of USDA food color standards. The current list includes:

- Frozen French Fry Standard
- Canned Ripe Olives Standard
- Tomato Grade A & C
- Maple Syrup Standards
- Molasses Standards
- Honey Standards
- Canned Tomato Color Standard
- Frozen Cherries Color Standard
- Pumpkin/Squash Color Standards

Lists are update periodically.  
Call 877-888-1720 for more information.

## Neutral Value Scales (Gray Scales)

The Munsell Neutral Value Scale is a 37-step gray scale fan deck with values of 0.5/ to 9.5/, in quarter step intervals. Munsell notation and % reflectance for CIE Illuminant C printed for each color. Size of each neutral chip 3" x 2" x 3/4" and it is available in glossy or matte finish editions.



## Munsell Educational Tools for Developing Color Knowledge and Application

Nuance is an elemental aspect of color. The more one knows about the nuances in color and how they work, the more one can effectively apply color in any form of communication. Munsell Color provides a selection of resources for learning more about color and color space. These resources are intelligently illustrated and feature exercises that give participants a real-world perspective on color and its successful application.

### **Munsell Color Tree**

This attractive, three-dimensional model makes it easy to comprehend the Munsell three-dimensional color space. It features 309 printed colors representing the constant hues, mounted on clear acrylic panels, assembled on a acrylic base. Height 10 1/2" Width 16" , Base Diameter 13.5".





### Fundamentals of Color and Appearance Book

This reference guide to basic color theory and practical application is written in easy to understand terms. It provides an introduction to the basics of color and appearance, including quantifying color, visual quality control, instrumentation, instrumental quality control and a comprehensive glossary of common color and appearance terms. It also serves as a guide to establishing a color quality control program.

### Fundamentals of Color Interactive Student Set

The Munsell Student Set is published by Fairchild Books and Visuals and is designed to teach the Munsell System and the concept of three-dimensional color space. Students build color knowledge by arranging color chips on blank charts. The set includes 11 charts — one for each of 10 hues, plus 1 hue, value/chroma (H V/C) chart showing hue circle, value scale, and chroma scale. Also includes The Munsell Color System — A Language for Color workbook by Joy Turner Luke.

### Munsell System Wall Chart

The Munsell System at a glance, this poster-sized (25" x 38") wall chart displays the Munsell System — featuring the 10-step hue circle, 8-step gray scale, and 6-step red chroma scale — for all trainees and staff to see.

A Munsell color chart is visible in the background, showing a grid of color patches numbered 20 through 50. The chart includes primary and secondary color labels like Y, GY, G, BG, B, PB, and P.

## Solutions for All of Your Color Requirements

From color education to establishing color standards to verifying color reproduction in all forms of product development and communication, X-Rite can help you implement a color management system that assures the highest levels of color quality and appearance. We provide the technology, the systems and the services to make every step of the color management process accurate, productive, and cost efficient.

**For more information, call us today at 877-888-1720 or visit [xrite.com](http://xrite.com).**



Process	Description Key	X-Rite products and services
Design	Product concept and colors	Color standards, lighting, books of color, spectrophotometers, software
Master standard	Corporate standards for colors	Color standards
Formulation	Manufacturing of dyestuffs, textiles, inks, paints, coatings and plastics	Instrumentation, software, lighting
Part production	In-process color control	Instrumentation, software, lighting, testing,
Final QC	Inspection of finished parts	Instrumentation, software, lighting, testing, auditing, color standards
Color harmony	Assurance of uniform color when parts are assembled into final product	Lighting, color standards (color tolerance cards)
Corporate QC	Verification of color harmony and conformance with customer color specifications	Testing, auditing
Retail	Customer inspection of incoming goods both at point of delivery as well as point of display	Lighting, testing, auditing, consulting color standards Testing, auditing
Merchandising	Assurance of good color match between products and promotional materials (brochures, catalogs, sell sheets, packaging, point-of-purchase displays)	Lighting, testing, auditing, consulting color standards Spectrophotometers, densitometers, lighting





## Refining the science of **COLOR**

To define color through precise color validation systems,  
contact Munsell Color at 877-888-1720 or visit [munsell.com](http://munsell.com).



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