

Contents

Introduction	1
1. Basic Facts	5
The Eye, 5	
Focusing Elements, 6	
<i>Cornea • Pupil • Lens • Vitreous Humor</i>	
Sensitive Elements, 8	
<i>Rods—Night Vision • Cones—Day Vision • Rods and Cones—Twilight Vision</i>	
Eye Pigments, 13	
<i>Lens • Macula • Blood • Choroid Coat • Rod and Cone Pigments</i>	
Interpretive Elements, 19	
<i>Retinal Side Paths • Brain</i>	
Some Open Questions in the Physiology of Color Vision, 26	
<i>Photopigments • Cones • Nerve Impulses • Form of Transmitted Color Information • Neural Correlate of Visual Surroundings</i>	
Fundamental Aspects of Color, 27	
Chemical—Pigments and Dyes, 28	
Physical—Radiant Energy and the Spectrum, 29	
Psychological—the Customer’s Angle, 32	
Psychophysical—How to Predict What the Average Customer Will See, 35	

Color Matching, 40

Addition of Color Stimuli, 41

Persistence of Color Matches • Grassmann's Laws • Tristimulus Color Space • Negative Tristimulus Values—an Interlude • Transformation of Primaries • Color-Matching Functions

Rapid Succession of Color Stimuli, 65

Mixture of Colorants, 68

Color Deficiencies, 68

Classification of Visual Systems, 69

Normal Trichromatism • Anomalous Trichromatism • Dichromatism • Monochromatism

Causes of Color Blindness, 74

Congenital Color Blindness • Acquired Color Blindness

Types of Color Vision in the Normal Eye, 77

Indirect Vision • Insufficient Size • Insufficient Brightness • Insufficient Time

Tests of Color Blindness, 79

Holmgren Wool Test • Nagel Charts • Stilling Charts • Ishihara Charts • AO H-R-R Test • Other Chart Tests • Anomaloscope

Theories of Color Vision, 81

2. Tools and Technics**91**

Spectrophotometry, 91

Selecting a Spectrophotometer, 96

Kinds of Specimen • Number of Specimens • Spectral Range • Precision, Accuracy • Miscellaneous Requirements

Fundamental Standards in Colorimetry, 102

Standard Illuminants and Sources, 105

CIE Standard Illuminant A • CIE Standard Illuminants B and C • CIE Standard Illuminant D₆₅ • Other CIE

Illuminants D • Chromaticity • Relative Spectral Power Distribution • Calculations • Artificial Sources Representative of CIE Standard Illuminants • CIE Standard Source A • CIE Standard Sources B and C • CIE Standard Sources D

Standard of Reflectance Factor, 122

Standard Illuminating and Viewing Conditions, 122

CIE 1931 Standard Colorimetric Observer, 125

CIE 1931 (x,y)-Chromaticity Diagram

CIE 1964 Supplementary Standard Colorimetric Observer, 134

CIE 1964 (x₁₀,y₁₀)-Chromaticity Diagram

Calculation of Tristimulus Values and Chromaticity Coordinates, 139

Weighted-Ordinate Method • Numerical Examples • Selected-Ordinate Method

CIE Supplementary Standard Observer Versus CIE 1931 Standard Observer, 153

Color Temperature and Correlated Color Temperature, 164

Dominant Wavelength and Purity, 170

Metamerism, 172

Degree of Metamerism • Metameric Difference

Colorimeters, 189

Visual Colorimeters, 189

Tristimulus Colorimeters • Subtractive Colorimeters • Color Comparators

Photoelectric Colorimeters, 203

Colorimetry by Difference, 211

Colorimetry of Fluorescent Materials, 219

Reproduction of Pictures in Color, 234

Color Standards, 244

Systematic Sampling of the Color Solid, 245

Colorant-Mixture Systems, 246

Color-Mixture Systems, 248

Screen-Plate Printing Color Systems, 252

Color-Appearance Systems, 255

Munsell System • DIN-Color Chart • Swedish Natural Color System • Regular Rhombohedral Lattice Sampling of Object-Color Space

Two-Dimensional Color Scales, 274

One-Dimensional Color Scales, 274

Nonsystematic and Incomplete Sampling of the Color Solid, 279

Uniform Color Scales, 281

Uniform Lightness Scales, 281

Uniform Chromaticness Scales, 292

Uniform Chromaticity-Scale Diagrams

Combined Lightness and Chromaticness Scales, 313

Boundary of Object-Color Solid • Line Elements • Whiteness Formulas

Color Tolerances, 342

Special Color Standards • Collections of Color Standards • Fundamentally Specified Standards • Color-Difference Formulas

Dark and Light Adaptation—Chromatic Adaptation, 352

Color Rendering of Light Sources, 362

Object-Color Perception in Complicated Scenes, 368

Color Languages, 373

Basic or Psychological Color Terms, 375

Psychophysical Color Terms, 376

General Terms • Ostwald Terms • Munsell Terms

Colorant Terms, 382

Color Names, 387

ISCC-NBS Method of Designating Colors

Color Harmony, 390

3. Physics and Psychophysics of Colorant Layers	397
Gloss, 398	
Fresnel Reflection, 399	
Types of Gloss, 402	
Connection between Gloss and Color, 411	
Opacity or Hiding Power, 413	
Kubelka-Munk Analysis, 420	
The Exponential Solution, 422	
The Hyperbolic Solutions, 426	
Simple Numerical Examples, 431	
Colorant Formulation, 438	
Identification of Colorants, 439	
<i>Clear Media • Turbid Media</i>	
Color-Match Predictions, 446	
<i>Trial and Error • Use of the CIE System • Use of the Kubelka-Munk Analysis • Use of Other Analyses</i>	
Appendix	462
References	501
Author Index	535
Subject Index	541