Contents

Preface xi

Shining Light, Shedding Light xiii
Roald Hoffmann

Communicating Science via Demonstrations xxi
Bassam Z. Shakhashiri

Sources Containing Descriptions of Lecture Demonstrations xxvii

Sources of Information on Hazards and Disposal xxxi

Displaying Small Phenomena to a Large Audience xxxiii

12 COLOR, LIGHT, VISION, PERCEPTION 1

Rodney Schreiner, Jerry A. Bell, and Bassam Z. Shakhashiri

Color 3
More Properties of Light 7
The Nature of Light 11
Electromagnetic Radiation 22
Interactions of Light and Matter 31
Vision 66
Perception 78
The Demonstrations 84

The Production of Light 85

12.1 The Emission Spectrum from a Candle Flame 87
12.2 The Temperature Dependence of the Emission Spectrum from an Incandescent Lamp 93
12.3 Incandescence from the Combustion of Iron and of Zirconium 98
12.4 Chemical Reactions That Produce Light 102
12.5 Emission Spectra from Gas-Discharge Lamps 103
12.6 Colored Flames from Metal Ions 108
12.7 Light-Emitting Diodes: Voltage and Temperature Effects 111
12.8 Electrogenerated Chemiluminescence 118
12.9 Chemiluminescence 123
12.10 Chemiluminescence from the Explosive Reaction of Nitrous Oxide and Carbon Disulfide 124

Properties of Light 127

12.11 The Conversion of Light Energy to Thermal Energy 129
12.12 Refraction and Diffraction: The Separation of White Light into Colors 131
12.13 Disappearing Glass: Index of Refraction 135
12.14 Disappearing Gel: Index of Refraction 141
12.15 Observing the Transmission Spectra of Dyes 146
12.16 Dichroism: Transmission versus Reflection 151
12.17 Iridescence from a Polymer Film 154
12.18 The Photoelectric Effect 156
12.19 The Tyndall Effect: Scattered Light Is Polarized 160
12.20 Rainbow Spiral in an Optically Active Solution 163
12.21 A Sugar Solution Between Polarizers 166
12.22 The Birefringence of Calcite 167
12.23 A Liquid Crystal Display through a Polarizer 171
12.24 Laser Light Is Polarized 175

Perception and Vision 179

12.25 Additive Color Mixing 181
12.26 Subtractive Primary Colors 189
12.27 The Perception of Brightness Is Relative 192
12.28 The Hermann-Grid Illusion 196
12.29 Finding the Blind Spot 201
12.30 The Land Effect 204
12.31 Saturation of the Retina: Afterimage 208
12.32 The Persistence of Vision 212
12.33 The Imprecision of Peripheral Vision 215
12.34 The Pulfrich Phenomenon: Perception of Motion 218

Photemission: Fluorescence and Phosphorescence 221

12.35 Photoluminescence 223
12.36 The Halide Quenching of Quinine Fluorescence 227
12.37 Differentiation of Fluorescence and Phosphorescence 232
12.38 Phosphorescence Excitation: Energy and Color Relationship 235
12.39 Quenching Phosphorescence with Light 238
12.40 Quenching Phosphorescence with Thermal Energy 241
12.41 The Fluorescence of Molecular Iodine Vapor 243

Photochemistry 247

12.42 The Reversible Photochemical Bleaching of Thionine 249
12.43 Photochromic Methylene Blue Solution 256
12.44 The Photochemical Reaction of Chlorine and Hydrogen 260
12.45 The Effects of Solvents on Spiropyran Photochromism and Equilibria 261
12.46 A Copper Oxide Photocell 274
12.47 The Photobleaching of Carotene 277

12.48 Making a Cyanotype 283
12.49 An Iron(III)-Oxalate Actinometer 287
12.50 The Photoreduction of Silver Halide 291
12.51 Photochemistry in Nitroprusside-Thiourea Solutions 293
12.52 Photochromism in Ultraviolet-Sensitive Beads 300
12.53 The Photodissociation of Bromine and the Bromination of Hydrocarbons 304
12.54 The Photochemical Formation and Reaction of Ozone 308

Index to Volumes 1–5 311

Illustration Credits 323