

CONTENTS

CHAPTER I

ELEMENTARY LAWS OF OPTICS

§ 1. Introduction. 2. Maxwell's electromagnetic theory of light. 3. The electromagnetic vectors. 4. The electromagnetic relations. 5. Plane waves. Heaviside's method. 6. Directions of D and B . 7. Directions of E and H . 8. Relations between E and H in an isotropic medium. 9. Velocity of propagation. 10. Periodic wave motion. 11. Periodic plane waves. 12. Rays. 13. Laws of reflexion. 14. Laws of refraction; Snell's Law. 15. Remarks on the laws of reflexion and refraction. 16. Refractive index. 17. Dispersion
[Pages 1 to 9]

CHAPTER II

SOME APPLICATIONS OF THE LAWS OF REFLEXION AND REFRACTION

§ 18. Relations between incident and reflected rays. 19. Image of a point by reflexion at a plane surface. 20. Relations between incident and refracted rays. 21. Geometrical image of a point by refraction at a plane surface. 22. Effect of a parallel plate. 23. Total reflexion. 24. Deviation of a ray by refraction. 25. Deviation of a nearly normal ray. 26. Deviation by a prism of a ray in a principal plane. 27. Deviation by a prism of small angle of a ray in a principal plane. 28. Deviation of a symmetrical ray in a principal plane. 29. Minimum deviation of a ray in a principal plane. 30. Effect of a prism on a ray not in a principal plane [Pages 10 to 19]

CHAPTER III

EXPERIMENTS WITH PLANE SURFACES

§ 31. Testing of glass plates by telescope.

Experiment 1. Verification of Snell's law.

§ 32. Method. 33. Practical details. 34. Practical example.

Experiment 2. Determination of refractive index of a liquid by total reflexion.

§ 35. Introduction. 36. Experimental details. 37. Practical example.

Experiment 3. Determination of refractive index of glass block by microscope.

§ 38. Method. 39. Practical example.

Experiment 4. Determination of refractive index of a liquid by microscope.

§ 40. Geometrical image of a point by refraction at any number of parallel plane surfaces. 41. Method. 42. Practical example.

Experiment 5. Determination of refractive index of liquid by concave mirror.

§ 43. Method. 44. Glass mirror silvered at the back. 45. Practical example
[Pages 20 to 36]

CHAPTER IV

THE SPECTROMETER

§ 46. Introduction. 47. Curvature of image of slit. 48. Focal lines formed by a prism. 49. Application to spectrometer. 50. Focusing of telescope and collimator. 51. Auto-collimation method. 52. Schuster's method. 53. Levelling the telescope. 54. Levelling the prism. 55. Position of prism on table. 56. Illumination of slit. 57. Use of two verniers.

Experiment 6. Determination of angle and refractive index of a prism by spectrometer.

§ 58. Apparatus. 59. Determination of angle of prism. 60. Determination of refractive index of prism. 61. Practical example.

Experiment 7. Determination of angle and refractive index of a prism by auto-collimating spectrometer.

§ 62. Apparatus. 63. Determination of angle of prism. 64. Determination of index of prism. 65. Practical example.

Experiment 8. Spectroscopic study of light from vacuum tube.

§ 66. Introduction. 67. The vacuum tube. 68. Optical measurements. 69. Discussion of results. 70. Practical example . . . [Pages 37 to 61]

CHAPTER V

EXPERIMENTS WITH PRISMS

§ 71. The goniometer.

Experiment 9. Measurement of angle and index of prism of small angle.

§ 72. Method. 73. Practical example.

Experiment 10. Determination of angle and index of prism of small angle by aid of liquid of known index.

§ 74. Method. 75. Experimental details. 76. Practical example.

Experiment 11. Determination of angle and index of prism of small angle by primary and secondary images.

§ 77. Method. 78. Practical example.

Experiment 12. Determination of angle between two nearly perpendicular mirrors.

§ 79. Method. 80. Practical example.

Experiment 13. Determination of angle of a prism of nearly 90° .

§ 81. Method. 82. Practical example.

Experiment 14. Measurement of angles of nominally right-angled prism.

§ 83. Method. 84. Practical example.

Experiment 15. The prism refractometer.

§ 85. Theory of refractometer. 86. Measurement of index of a liquid. 87. The auxiliary prism. 88. Experimental details. 89. Practical example.

Experiment 16. Determination of pyramidal error of prism.

§ 90. Introduction. 91. Method. 92. Practical example.

Experiment 17. Determination of angles of a nearly equilateral prism.

§ 93. Method. 94. Practical example.

Experiment 18. Range finding by prism of constant deviation.

§ 95. Design of prism of constant deviation. 96. Theory of method. 97. Experimental details. 98. Practical example . . . [Pages 62 to 93]

CHAPTER VI

SPHERICAL MIRRORS

§ 99. Image formed by spherical mirror.

Experiment 19. Measurement of radius and focal length of concave mirror.

§ 100. First method. 101. Second method. 102. Third method. 103. Fourth method. 104. Practical example.

Experiment 20. Measurement of radius of convex mirror by use of converging lens.

§ 105. Method. 106. Practical example.

Experiment 21. Measurement of focal length of convex mirror.

§ 107. Direct method. 108. Goniometer method. 109. Practical example.

Experiment 22. Determination of radius of spherical surface by revolving table method.

§ 110. Method. 111. Experimental details. 112. Measurement of radius. 113. Practical example.

Experiment 23. Measurement of radius of mirror by Chalmers's method.

§ 114. Method. 115. Experimental details. 116. Practical example.

Experiment 24. Determination of focal length of thick mirror.

§ 117. Theory of thick mirror. 118. Gauss's method. 119. Practical example. 120. Micrometer method. 121. Practical example. 122. Goniometer method. 123. Practical example . . . [Pages 94 to 116]

CHAPTER VII

THIN LENSES

§ 124. Refraction at a spherical surface. 125. Deviation method. 126. Newton's formula. 127. Thin lens separating two media. 128. The magnification. 129. The elongation. 130. Combination of two thin lenses in contact in air. 131. Power of a lens. 132. Application of principle of least time to find primary image. 133. Secondary image. 134. Images by once reflected rays. 135. Secondary powers for n thin lenses in contact . . . [Pages 117 to 130]

CHAPTER VIII

EXPERIMENTS WITH THIN LENSES

Experiment 25. Measurement of focal length of converging lens by use of distant object.

§ 136. Method. 137. Corrections for finite distance and for thickness. 138. Practical example.

Experiment 26. Measurement of focal length of converging lens by use of plane mirror.

§ 139. First method. 140. Second method. 141. Practical example.

Experiment 27. Measurement of focal length of thin converging lens by conjugate points.

§ 142. Introduction. 143. First method. 144. Second method. 145. Third method. 146. Practical example.

Experiment 28. Measurement of focal length of diverging lens.

§ 147. Introduction. 148. Combination of converging with diverging lens. 149. First method. 150. Second method. 151. Practical example.

Experiment 29. Measurement of power of weak lens.

§ 152. First method. 153. Second method. 154. Practical example.

Experiment 30. Test of relation between elongation and magnification.

§ 155. Method. 156. Practical example.

Experiment 31. Measurement of radii of curvature of thin lens by Boys's method.

§ 157. Converging lens. 158. Lens of finite thickness. 159. Experimental details. 160. Diverging lens. 161. Practical example.

Experiment 32. Determination of index of lens by flare spot method.

§ 162. Method. 163. Practical example.

Experiment 33. Flare spots with two lenses.

§ 164. Secondary powers for two thin lenses in contact. 165. Experimental details. 166. Practical example.

Experiment 34. Test of formula for thin lens separating two media.

§ 167. Method. 168. Practical example.

Experiment 35. Determination of index of a liquid or of a thin lens by use of liquid of known index.

§ 169. Method for liquid. 170. Correction for thickness of lens. 171. Methods for thin lens. 172. Practical example.

Experiment 36. Determination of index of lens by immersion in liquid of known index.

§ 173. Method. 174. Correction for thickness of lens. 175. Practical example
[Pages 131 to 157]

CHAPTER IX

COAXIAL OPTICAL SYSTEMS—THICK LENSES

§ 176. Introduction. 177. Approximate treatment of spherical surfaces. 178. Refraction at a spherical surface. 179. Conjugate points. 180. Conjugate planes. 181. Magnification. 182. Helmholtz's formula for refraction. 183. Helmholtz's formula for reflexion. 184. Four properties of a spherical refracting or reflecting surface. 185. Foci and focal planes of a coaxial system. 186. Principal planes and principal points. 187. Focal lengths. 188. Formula for conjugate points. 189. Ratio of focal lengths. 190. Newton's formula. 191. Nodal points. 192. Cardinal points of a coaxial system. 193. Deviation formula for a system in a single medium. 194. Calculation of the positions of the cardinal points. 195. Cardinal points of thick lens separating two media. 196. Thick lens surrounded by air. 197. Lens in air with one face plane. 198. Approximate results for a thin lens in air. 199. Cardinal points of a compound system in air. 200. Telescopic systems. 201. Transverse magnification of a telescope. 202. Magnifying power of a telescope. 203. Longitudinal magnification. 204. Formulae when $\mu_1 = \mu_2$ [Pages 158 to 178]

CHAPTER X

EXPERIMENTS WITH COAXIAL SYSTEMS

§ 205. Notes on practical work with lens systems. 206. Measuring rods. 207. The optical bench. 208. Adjustment of thin converging lens. 209. Adjustment of plane mirror. 210. Adjustment of lens system. 211. Use of distance rod. 212. Experiments with system giving virtual image of distant object.

Experiment 37. Determination of cardinal points by Newton's method.

§ 213. Method. 214. Practical example.

Experiment 38. Determination of cardinal points by Gauss's method.

§ 215. Method. 216. System giving virtual image of distant object. 217. Practical example.

Experiment 39. Determination of focal length by the method of magnification.

§ 218. Introduction. 219. Method. 220. Positions of principal points. 221. Practical example.

Experiment 40. Determination of focal length by micrometer method.

§ 222. Method. 223. Practical example.

Experiment 41. Direct determination of positions of principal points.

§ 224. Method. 225. Practical example.

Experiment 42. Determination of cardinal points by nodal point method.

§ 226. Introduction. 227. Apparatus. 228. Adjustment of graduated bar. 229. Determination of distance between nodal points. 230. Determination of focal length. 231. Use of a plane mirror. 232. System giving virtual image of distant object. 233. Practical examples.

- Experiment 43.** Measurement of focal lengths by goniometer.
 § 234. Introduction. 235. Experimental details. 236. Application to microscope objective. 237. System giving virtual image of distant object. 238. Practical examples.
- Experiment 44.** Determination of the optical constants of a model eye.
 § 239. Introduction. 240. Method of magnification. 241. Newton's method. 242. Goniometer method. 243. Revolving table method. 244. Practical example.
- Experiment 45.** Determination of radii of curvature of a lens.
 § 245. Method. 246. Practical example.
- Experiment 46.** Determination of cardinal points of lens by Bravais points.
 § 247. Theory. 248. Simple method. 249. Micrometer method. 250. Auxiliary lens method. 251. Practical example.
- Experiment 47.** Anharmonic property of lens system.
 § 252. Anharmonic ratios. 253. Experimental details. 254. Practical example.
- Experiment 48.** Study of telescopic system.
 § 255. Apparatus. 256. Measurement of transverse magnification. 257. Measurement of longitudinal magnification. 258. Measurement of magnifying power. 259. Practical example.
- Experiment 49.** Determination of effective aperture of stop of photographic lens.
 § 260. Notation for stops. 261. Stop in front of lens. 262. Stop between components of lens system. 263. First method. 264. Second method. 265. Third method. 266. A system for laboratory work. 267. Practical example. [Pages 179 to 237]

CHAPTER XI

ASTIGMATISM AND FOCAL LINES

- § 268. Non-spherical wave front. 269. Lines of curvature. 270. Focal lines. 271. Circle of least confusion.
- Experiment 50.** Focal lines formed by concave mirror.
 § 272. Introduction. 273. Observation of focal lines and of circle of least confusion. 274. Experimental test of formulae. 275. Practical example.
- Experiment 51.** Focal lines by refraction at plane surface.
 § 276. Introduction. 277. Experimental details. 278. Practical example.
- Experiment 52.** Measurement of powers of thin astigmatic lenses.
 § 279. Introduction. 280. Circle of least confusion. 281. Experimental details. 282. Practical example.
- Experiment 53.** Study of astigmatism due to pair of plano-cylindrical lenses.
 § 283. Introduction. 284. Focal lengths of system. 285. Circle of least confusion. 286. Practical details. 287. Practical example.

- Experiment 54.** Focal lines due to sloped lens.
 § 288. Introduction. 289. Method of least time. 290. Practical details. 291. Practical example.
- Experiment 55.** Curvature of the field.
 § 292. Introduction. 293. Image surfaces. 294. Curvature of image surfaces at vertex. 295. Forms of image surfaces. 296. Experimental details. 297. Practical example.
- Experiment 56.** Curvature of field of lens system and effect of position of stop.
 § 298. Method. 299. Effect of position of stop. 300. Practical example
 [Pages 238 to 273]

CHAPTER XII

INTERFERENCE AND POLARISATION BY REFLEXION

- § 301. Introduction. 302. Boundary conditions. 303. Normal incidence. 304. Oblique incidence. 305. Retardation due to parallel plate. 306. Ratios of electric forces for normal incidence. 307. Ratios of electric forces for oblique incidence. 308. Results when $\mu'' = \mu'$. 309. Interference due to thin plate or film. 310. Effect of multiple reflexions.
- Experiment 57.** Measurement of wave length by Newton's rings.
 § 311. Introduction. 312. Newton's rings. 313. Experimental details. 314. Special apparatus. 315. Practical example.
- Experiment 58.** Measurement of refractive index of a liquid by Newton's rings.
 § 316. Method. 317. Practical example.
- Experiment 59.** Measurement of angle between two nearly parallel plates.
 § 318. Method. 319. Experimental details. 320. Practical example.
- Experiment 60.** Measurement of thickness of air film by interference method.
 § 321. Method. 322. Experimental details. 323. Practical example.
- Experiment 61.** Determination of polarising angle.
 § 324. Introduction. 325. Method. 326. Practical example.
- Experiment 62.** Resolving power of a telescope.
 § 327. Introduction. 328. The diffraction pattern. 329. Case of two slits. 330. Case of many slits. 331. Experimental details. 332. Practical example.
- Experiment 63.** Measurement of wave length by interference with two slits.
 § 333. Introduction. 334. Slits of finite width. 335. Experimental details. 336. Practical example [Pages 274 to 317]

CHAPTER XIII

DIFFRACTION GRATING AND ZONE PLATE

§ 337. The plane grating. 338. The axes of a grating. 339. Diffraction by transmission grating. 340. Minimum deviation. 341. Effect of finite width of openings. 342. Reflexion grating. 343. Diffraction of rays incident in any direction.

Experiment 64. Determination of wave length by diffraction grating.

§ 344. Introduction. 345. Adjustment of grating. 346. Method of normal incidence. 347. Practical example.

Experiment 65. Measurement of wave length by auto-collimating spectrometer.

§ 348. Method. 349. Experimental details. 350. Practical example.

Experiment 66. The sloped grating.

§ 351. Introduction. 352. Apparatus. 353. Experimental details. 354. Practical example.

Experiment 67. Measurement of wave length by grating, using convergent light.

§ 355. Introduction. 356. Method. 357. Practical example.

Experiment 68. Measurement of wave length by zone plate.

§ 358. Theory of zone plate. 359. Openings of finite width. 360. Construction of a zone plate. 361. Measurement of zones. 362. Measurement of focal lengths. 363. Calculation of wave length. 364. Practical example.

Experiment 69. Determination of thickness of film by banded spectrum.

§ 365. Introduction. 366. Banded spectrum. 367. Experimental details. 368. The plates. 369. Further discussion. 370. Practical example.

Experiment 70. Measurement of thickness of air film by circular fringes.

§ 371. Introduction. 372. Apparatus. 373. Circular fringes. 374. Practical details. 375. Practical example [Pages 318 to 357]