57. **a.** 24.7°
b. It will pass through the bottom surface because $\theta_i < \theta_c$ ($\theta_c = 41.8°$).
59. 1.38
61. 58.0 m
63. **a.** 4.83 cm
b. The lens must be moved 0.12 cm.
65. 1.90 cm

CHAPTER 15

Practice A, p. 531

1. 5.1×10^{-7} m = 5.1×10^{2} nm
3. 0.125°

Practice B, p. 538

1. 0.02°, 0.04°, 0.11°
3. 11
5. 6.62×10^{3} lines/cm

15 Review, pp. 548–551

5. θ would decrease because λ is shorter in water.
9. 630 nm
11. 160 μm
19. 3.22°
21. **a.** 10.09°, 13.71°, 14.77°
b. 20.51°, 28.30°, 30.66°
29. 432.0 nm
31. 1.93×10^{-3} mm = 3 λ; a maximum

CHAPTER 16

Practice A, p. 566

1. 230 N (attractive)
3. 0.393 m

Practice B, p. 568

1. 47 N, along the negative x-axis; 157 N, along the positive x-axis; 11.0×10^{1} N, along the negative x-axis

Practice C, p. 570

1. $x = 0.62$ m
3. 5.07 m

Practice D, p. 575

1. 1.66×10^{5} N/C, 81.1° above the positive x-axis
3. **a.** 3.2×10^{-15} N, along the negative x-axis
b. 3.2×10^{-15} N, along the positive x-axis

16 Review, pp. 581–585

15. 3.50×10^{3} N
17. 91 N (repulsive)
19. 1.48×10^{-7} N, along the $+x$ direction
21. 18 cm from the 3.5 nC charge
33. 5.7×10^{3} N/C, 75° above the positive x-axis
35. **a.** 5.7×10^{-27} N, in a direction opposite **E**
b. 3.6×10^{-8} N/C
37. **a.** 2.0×10^{7} N/C, along the positive x-axis
b. 4.0×10^{1} N
41. 7.2×10^{-9} C
43. $v_{electron} = 4.4 \times 10^{6}$ m/s; $v_{proton} = 2.4 \times 10^{3}$ m/s
45. 5.4×10^{-14} N
47. 2.0×10^{-6} C
49. 32.5 m
51. **a.** 5.3×10^{17} m/s^2
b. 8.5×10^{-4} m
c. 2.9×10^{14} m/s^2
53. **a.** positive
b. 5.3×10^{-7} C
55. **a.** 1.3×10^{4} N/C
b. 4.2×10^{6} m/s

CHAPTER 17

Practice A, p. 599

1. 6.4×10^{-19} C
3. 2.3×10^{-16} J

Practice B, p. 607

1. **a.** 4.80×10^{-5} C
b. 4.50×10^{-6} J
3. **a.** 9.00 V
b. 5.0×10^{-12} C

Practice C, p. 609

1. 4.00×10^{2} s
3. 6.00×10^{2} s
5. **a.** 2.6×10^{-3} A
b. 1.6×10^{17} electrons
c. 5.1×10^{-3} A

Practice D, p. 615

1. 0.43 A
3. **a.** 2.5 A
b. 6.0 A
5. 46 Ω

Practice E, p. 621

1. 14 Ω
3. 1.5 V
5. 5.00×10^{2} A

17 Review, pp. 626–631

9. -4.2×10^{5} V
19. 0.22 J
23. $v_{avg} >> v_{drift}$
33. **a.** 3.5 min
b. 1.2×10^{22} electrons
41. 3.4 A
49. 3.6×10^{6} J
51. the 75 W bulb
53. 2.0×10^{16} J