3.A: Photons and Matter Waves (Answer)

Check Your Understanding

6.1. Bunsen's burner

6.2. The wavelength of the radiation maximum decreases with increasing temperature.

6.3. $T_\alpha / T_\beta = 1/\sqrt{3} \cong 0.58$, so the star β is hotter.

6.4. $3.3 \times 10^{-19} J$

6.5. No, because then $\Delta E/E \approx 10^{-21}$

6.6. $-0.91V; 1040nm$

6.7. $h = 6.40 \times 10^{-34} J \cdot s = 4.0 \times 10^{-15} eV \cdot s; -3.5$

6.8. $(\Delta\lambda)_{min} = 0m$ at a 0° angle; $71.0pm + 0.5\lambda_c = 72.215pm$

6.9. 121.5 nm and 91.1 nm; no, these spectral bands are in the ultraviolet

6.10. $v_2 = 1.1 \times 10^6 m/s \cong 0.0036c$; $L_2 = 2\hbar K_2 = 3.4eV$

6.11. 1.7 pm

6.12. $\lambda = 2\pi n a_0 = 2(3.324\text{Å}) = 6.648\text{Å}$

6.13. $\lambda = 1.417pm; K = 261.56keV$

6.14. 0.052°

6.15. doubles it

Conceptual Questions

1. yellow

3. goes from red to violet through the rainbow of colors

5. would not differ

7. human eye does not see IR radiation

9. No

11. from the slope

13. Answers may vary

15. the particle character

17. Answers may vary

19. no; yes

21. no

23. right angle

25. no

27. They are at ground state.

29. Answers may vary

31. increase

33. for larger n

35. Yes, the excess of 13.6 eV will become kinetic energy of a free electron.

37. no

39. X-rays, best resolving power

41. proton

43. negligibly small de Broglie's wavelengths

45. to avoid collisions with air molecules

47. Answers may vary

49. Answers may vary

51. yes

53. yes

Problems

55. a. 0.81 eV;

b. 2.1×10^{23};

c. 2 min 20 sec

57. a. 7245 K;

b. 3.62 μm

59. about 3 K

61. 4.835×10^{18}Hz; 0.620 Å

63. 263 nm; no

65. 369 eV

67. 4.09 eV

69. 5.60 eV

71. a. 1.89 eV;

b. 459 THz;

c. 1.21 V

73. 264 nm; UV

75. $1.95 \times 10^{6} m/s$

77. $1.66 \times 10^{-32} kg \cdot m/s$

79. 5620 eV

81. $6.63 \times 10^{-23} kg \cdot m/s$; 124 keV

83. 82.9 fm; 15 MeV

85. (Proof)

87. $\Delta\lambda_{30}/\Delta\lambda_{45} = 45.74$

89. 121.5 nm

91. a. 0.661 eV;

b. –10.2 eV;

c. 1.511 eV

93. 3038 THz

95. 97.33 nm

97. a. h/π;

b. 3.4 eV;

c. – 6.8 eV;

d. – 3.4 eV

99. $n = 4$

101. 365 nm; UV

103. no

105. 7

107. 145.5 pm

109. 20 fm; 9 fm

111. a. 2.103 eV;

b. 0.846 nm

113. 80.9 pm

115. $2.21 \times 10^{-20} m/s$

117. 9.929×10^{32}

119. $\gamma = 1060; 0.00124 fm$

121. 24.11 V

123. a. $P = 2I/c = 8.67 \times 10^{-6} N/m^2$;

b. $a = PA/m = 8.67 \times 10^{-4} m/s^2$;

c. $74.91 m/s$

125. $x = 4.965$

Additional Problems

127. $7.124 \times 10^{16} W/m^3$

129. 1.034 eV

131. 5.93×10^{18}

133. 387.8 nm

135. a. 4.02×10^{15};

b. 0.533 mW

137. a. 4.02×10^{15};

b. 0.533 mW;

c. 0.644 mA;

d. 2.57 ns

139. a. 0.132 pm;

b. 9.39 MeV;

c. 0.047 MeV

141. a. 2 kJ;

b. $1.33 \times 10^{-5} kg \cdot m/s$;

c. $1.33 \times 10^{-5} N$;

d. yes

143. a. 0.003 nm;

b. 105.56°

145. $n = 3$

147. a. $a_0/2$;

b. $-54.4eV/n^2$;

c. $a_0/3, -122.4eV/n^2$

149. a. 36;

b. 18.2 nm;

c. UV

151. 396 nm; 5.23 neV

153. 7.3 keV

155. 728 m/s; $1.5\mu V$

157. $\lambda = hc/\sqrt{K(2E_0 + K)} = 3.705nm, K = 100keV$

159. $\Delta\lambda_c^{(electron)}/\Delta\lambda^{(proton)} c_= m_p/m_e = 1836$

161. (Proof)

163. $5.1 \times 10^{17} Hz$.
