

## 5.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  $\beta$  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  $0^\circ$  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.  $\lambda = 2\pi na_0 = 2(3.324\text{\AA}) = 6.648\text{\AA}$
- 6.13.  $\lambda = 1.417pm$ ;  $K = 261.56keV$
- 6.14.  $0.052^\circ$
- 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.  $2.1 \times 10^{23}$ ;  
c. 2 min 20 sec
- 57. a. 7245 K;  
b. 3.62  $\mu\text{m}$
- 59. about 3 K
- 61.  $4.835 \times 10^{18} \text{ Hz}$ ; 0.620  $\text{\AA}$
- 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.  $1.95 \times 10^6 \text{ m/s}$
- 77.  $1.66 \times 10^{-32} \text{ kg} \cdot \text{m/s}$
- 79. 5620 eV
- 81.  $6.63 \times 10^{-23} \text{ kg} \cdot \text{m/s}$ ; 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.  $h/\pi$ ;

- 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.  $9.929 \times 10^{32}$

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.  $5.93 \times 10^{18}$

133. 387.8 nm

135. a.  $4.02 \times 10^{15}$ ;

b. 0.533 mW

137. a.  $4.02 \times 10^{15}$ ;

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.  $105.56^\circ$

145.  $n = 3$

147. a.  $a_0/2$ ;

b.  $-54.4\text{eV}/n^2$ ;

c.  $a_0/3, -122.4\text{eV}/n^2$

149. a. 36;

b. 18.2 nm;

c. UV

151. 396 nm; 5.23 neV

153. 7.3 keV

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

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

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

161. (Proof)

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

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