

## Chapter Seven

- 7.4 See Figure 7.2.
- 7.9  $\lambda\nu = c$ , where  $c$  is a constant equal to the speed of light,  $\lambda$  is the wavelength and  $\nu$  is the frequency.
- 7.10  $E = h\nu$ , where  $E$  is the energy,  $h$  is Planck's constant and  $\nu$  is the frequency.
- 7.15 An atomic spectrum consists of a series of discrete (selected, definite and reproducible) frequencies (and therefore of discrete energies) that are emitted by atoms that have been excited. The particular values for the emission frequencies are characteristic of the element at hand. In contrast, a continuous spectrum, such as that emitted by the sun or another hot, glowing object, contains all frequencies and, therefore, photons of all energies.
- 7.31  $n = 1, 2, 3, 4, 5, \dots$
- 7.34 (a) 1 (b) 3 (c) 5 (d) 7
- 7.35 Yes, if the value for  $\ell$  for this electron is 3 or larger.
- 7.36 The only impossible set of legitimate quantum numbers would be an electron having the exact same values for the four quantum numbers. Recall the Pauli Exclusion Principle.
- 7.38 Atoms with unpaired electrons are termed paramagnetic.
- 7.39 No two electrons in the same atom can have exactly the same set of values for all of the four quantum numbers. This limits the allowed number of electrons per orbital to two, since with other quantum numbers being necessarily the same, two electrons in the same orbital must at least have different values of  $m_s$ .
- 7.45
- |    |                  |    |                  |
|----|------------------|----|------------------|
| Li | $1s^2 2s^1$      | N  | $1s^2 2s^2 2p^3$ |
| Be | $1s^2 2s^2$      | O  | $1s^2 2s^2 2p^4$ |
| B  | $1s^2 2s^2 2p^1$ | F  | $1s^2 2s^2 2p^5$ |
| C  | $1s^2 2s^2 2p^2$ | Ne | $1s^2 2s^2 2p^6$ |
- 7.46 (a) Cr  $[\text{Ar}]4s^1 3d^5$  or  $[\text{Ar}]3d^5 4s^1$   
 (b) Cu  $[\text{Ar}]4s^1 3d^{10}$  or  $[\text{Ar}]3d^{10} 4s^1$
- 7.50 As explained by the Heisenberg Uncertainty Principle, the position and momentum of an electron cannot be known with 100% certainty, therefore it is impossible to know where an electron is, but we can determine the probability of finding an electron in a given space. An electron is visualized as being within a cloud around the nucleus. This electron cloud defines a volume in space where the probability of finding an electron is high.
- 7.51 (a) See Figures 7.22a and 7.23 (b) See Figures 7.24a, 7.25 and 7.26.
- 7.74 
$$\nu = \frac{c}{\lambda} = \frac{3.00 \times 10^8 \text{ m/s}}{280 \times 10^{-9} \text{ m}} = 1.07 \times 10^{15} \text{ s}^{-1} = 1.07 \times 10^{15} \text{ Hz}$$
- 7.76 
$$\nu = \frac{c}{\lambda} = \frac{3.00 \times 10^8 \text{ m/s}}{0.48 \times 10^{-6} \text{ m}} = 6.25 \times 10^{14} \text{ s}^{-1} = 6.25 \times 10^{14} \text{ Hz}$$
- 7.84  $E = h\nu = hc/\lambda$ , and  $560 \text{ nm} = 560 \times 10^{-9} \text{ m}$
- $$E = \frac{hc}{\lambda} = \frac{(6.63 \times 10^{-34} \text{ J s})(3.00 \times 10^8 \text{ m/s})}{(560 \times 10^{-9} \text{ m})} = 3.55 \times 10^{-19} \text{ J}$$

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- 7.92 (a) 3 (b) 2
- 7.94 (a)  $n=4, \ell=1$  (b)  $n=6, \ell=3$
- 7.96  $n=8$
- 7.98  $-5, -4, -3, -2, -1, 0, 1, 2, 3, 4, 5$
- 7.100 Thus there are eleven orbitals. There are eleven values for  $m_\ell$ :  $-5, -4, -3, -2, -1, 0, 1, 2, 3, 4, 5$ .
- 7.102
- | $n$ | $\ell$ | $m_\ell$ | $m_s$ |
|-----|--------|----------|-------|
| 3   | 2      | -2       | +1/2  |
| 3   | 2      | -2       | -1/2  |
| 3   | 2      | -1       | +1/2  |
| 3   | 2      | -1       | -1/2  |
| 3   | 2      | 0        | +1/2  |
| 3   | 2      | 0        | -1/2  |
| 3   | 2      | 1        | +1/2  |
| 3   | 2      | 1        | -1/2  |
| 3   | 2      | 2        | +1/2  |
| 3   | 2      | 2        | -1/2  |
- 7.106 (a) As  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^3$   
 (b) Cl  $1s^2 2s^2 2p^6 3s^2 3p^5$   
 (c) Ni  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^8$   
 (d) Si  $1s^2 2s^2 2p^6 3s^2 3p^2$
- 7.108 (a) Ba is  $[\text{Xe}]6s^2$ , zero unpaired electrons: diamagnetic  
 (b) Se is  $[\text{Ar}]4s^2 3d^{10} 4p^4$ , two unpaired electrons: paramagnetic  
 (c) Zn is  $[\text{Ar}]4s^2 3d^{10}$ , zero unpaired electrons: diamagnetic  
 (d) Si is  $[\text{Ne}]3s^2 3p^2$ , two unpaired electrons: paramagnetic
- 7.110 (a) Cs is  $[\text{Xe}]6s^1$ , 1 unpaired electron  
 (b) S is  $[\text{Ne}]3s^2 3p^4$ , 2 unpaired electrons  
 (c) Ni is  $[\text{Ar}]4s^2 3d^8$ , 2 unpaired electrons
- 7.112 (a) Al  $[\text{Ne}]3s^2 3p^1$   
 (b) Se  $[\text{Ar}]4s^2 3d^{10} 4p^4$  or  $[\text{Ar}]3d^{10} 4s^2 4p^4$   
 (c) Ba  $[\text{Xe}]6s^2$   
 (d) Sb  $[\text{Kr}]5s^2 4d^{10} 5p^3$  or  $[\text{Kr}]4d^{10} 5s^2 5p^3$   
 (e) Gd  $[\text{Xe}]6s^2 4f^7 5d^1$  or  $[\text{Xe}]4f^7 5d^1 6s^2$
- 7.118 The value corresponds to the row in which the element resides:  
 (a) 3 (b) 4 (c) 6 (d) 5
- 7.126 (a) Al (b) Tl
- 7.130 Cations are generally smaller than the corresponding atom, and anions are generally larger than the corresponding atom:  
 (a)  $\text{S}^{2-}$  (b) Al (c)  $\text{Au}^+$
- 7.132 (a) Li (b) F (c) F