SECTION 5.1 MODELS OF THE ATOM (pages 127–132)

This section summarizes the development of atomic theory. It also explains the significance of quantized energies of electrons as they relate to the quantum mechanical model of the atom.

The Development of Atomic Models (pages 127–128)

1. Complete the table about atomic models and the scientists who developed them.

<table>
<thead>
<tr>
<th>Scientist</th>
<th>Model of Atom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dalton</td>
<td>SOLID SPHERE</td>
</tr>
<tr>
<td>Thomson</td>
<td>PLUM PUDDING</td>
</tr>
<tr>
<td></td>
<td>E- EMBEDDED IN SOLID SPHERE</td>
</tr>
<tr>
<td>Rutherford</td>
<td>IDENTIFIABLE NUCLEUS THAT'S REALLY REALLY SMALL SURROUNDED BY ELECTRONS</td>
</tr>
<tr>
<td>Bohr</td>
<td>LIKE RUTHERFORD BUT ELECTRONS SPINNING AT SET ORBITS</td>
</tr>
</tbody>
</table>

2. Is the following sentence true or false? The electrons in an atom can exist between energy levels. **FALSE**

The Bohr Model (pages 128–129)

3. What are the fixed energies of electrons called? **QUANTA**

4. Circle the letter of the term that completes the sentence correctly. A quantum of energy is the amount of energy required to
   a. move an electron from its present energy level to a lower one
   b. maintain an electron in its present energy level
   c. move an electron from its present energy level to a higher one

5. In general, the higher the electron is on the energy ladder, the **FARTHER** it is from the nucleus.
CHAPTER 5, Electrons in Atoms (continued)

1. What is the difference between the previous models of the atom and the modern quantum mechanical model? NO EXACT PATH, STATISTICAL MODEL DEFINING THE BOUNDARIES OF LIKELY LOCATIONS.

7. Is the following sentence true or false? The quantum mechanical model of the atom estimates the probability of finding an electron in a certain position.

Atomic Orbitals (pages 131–132)

8. An orbital is often thought of as a region of space in which there is a high probability of finding an electron.

9. Circle the letter of the term that is used to label the energy levels of electrons:
   a. atomic orbitals  
   b. quantum mechanical numbers  
   c. quantas  
   d. principal quantum numbers (n)

10. The letter ________ is used to denote a spherical orbital.

11. Label each diagram below $p_x$, $p_y$, or $p_z$.

12. Use the diagram above. Describe how the $p_x$, $p_y$, and $p_z$ orbitals are similar.

13. Describe how the $p_x$, $p_y$, and $p_z$ orbitals are different.

14. Circle the letter of the formula for the maximum number of electrons that can occupy a principal energy level. Use $n$ for the principal quantum number.
   a. $2n^2$  
   b. $n^2$  
   c. $2n$  
   d. $n$  

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SECTION 5.2 ELECTRON ARRANGEMENT IN ATOMS (pages 133–136)

This section shows you how to apply the aufbau principle, the Pauli exclusion principle, and Hund's rule to help you write the electron configurations of elements. It also explains why the electron configurations for some elements are exceptions to the aufbau principle.

**Electron Configurations (pages 133–135)**

1. The ways in which electrons are arranged into orbitals around the nuclei of atoms are called **configurations**.

Match the name of the rule used to find the electron configurations of atoms with the rule itself.

- **0. aufbau principle**
- **1. Pauli exclusion principle**
- **2. Hund's rule**

Match the name of the rule used to find the electron configurations of atoms with the rule itself.

- a. When electrons occupy orbitals of equal energy, one electron enters each orbital until all the orbitals contain one electron with the same spin direction.
- b. Electrons occupy orbitals of lowest energy first.
- c. An atomic orbital may describe at most two electrons.

5. Look at the aufbau diagram, Figure 5.7 on page 133. Which atomic orbital is of higher energy, a 4f or a 5p orbital?

6. Fill in the electron configurations for the elements given in the table. Use the orbital filling diagrams to complete the table.

<table>
<thead>
<tr>
<th>Element</th>
<th>1s</th>
<th>2s</th>
<th>2p_1</th>
<th>2p_2</th>
<th>3s</th>
<th></th>
<th>Electron configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>T</td>
<td>T</td>
<td></td>
<td></td>
<td>T</td>
<td>T</td>
<td>1s^1</td>
</tr>
<tr>
<td>He</td>
<td>T</td>
<td>T</td>
<td></td>
<td></td>
<td>T</td>
<td>T</td>
<td>1s^2 Ne^2</td>
</tr>
<tr>
<td>Li</td>
<td>T</td>
<td>T</td>
<td>T</td>
<td></td>
<td>T</td>
<td>T</td>
<td>1s^2 2s^2 2p^1</td>
</tr>
<tr>
<td>C</td>
<td>T</td>
<td>T</td>
<td>T</td>
<td>T</td>
<td>T</td>
<td>T</td>
<td>1s^2 2s^2 2p^2</td>
</tr>
<tr>
<td>N</td>
<td>T</td>
<td>T</td>
<td>T</td>
<td>T</td>
<td>T</td>
<td>T</td>
<td>1s^2 2s^2 2p^3</td>
</tr>
<tr>
<td>O</td>
<td>T</td>
<td>T</td>
<td>T</td>
<td>T</td>
<td>T</td>
<td>T</td>
<td>1s^2 2s^2 2p^4</td>
</tr>
<tr>
<td>F</td>
<td>T</td>
<td>T</td>
<td>T</td>
<td>T</td>
<td>T</td>
<td>T</td>
<td>1s^2 2s^2 2p^5</td>
</tr>
<tr>
<td>Ne</td>
<td>T</td>
<td>T</td>
<td>T</td>
<td>T</td>
<td>T</td>
<td>T</td>
<td>1s^2 2s^2 2p^6 3s^1</td>
</tr>
</tbody>
</table>
CHAPTER 5, Electrons in Atoms (continued)

7. In an electron configuration, what does a superscript stand for?
   _______ of electrons in the orbital

8. In an electron configuration, what does the sum of the superscripts equal?
   The total # of e⁻ in atom

► Exceptional Electron Configurations (page 136)

9. Is the following sentence true or false?
   Every element in the periodic table follows the aufbau principle.
   FALSE

10. Filled energy sublevels are more _______ than partially filled sublevels.

11. Half-filled levels are not as stable as _______ levels, but are more stable than other configurations.

Reading Skill Practice

Outlining can help you understand and remember what you have read. Prepare an outline of Section 5.2, Electron Arrangement in Atoms. Begin your outline by copying the headings from the textbook. Under each heading, write the main idea. Then list the details that support, or back up, the main idea. Do your work on a separate sheet of paper.

SECTION 5.3 PHYSICS AND THE QUANTUM MECHANICAL MODEL (pages 138–146)

This section describes the variables used to describe light. It also explains how atomic emission spectra are produced, and compares the dual wave-particle nature of light and electrons.

► Light (pages 138–140)

1. Match each term describing waves to its definition.

   A  amplitude
   B  wavelength
   C  frequency

   a. the distance between two crests
   b. the wave’s height from zero to the crest
   c. the number of wave cycles to pass a given point per unit of time
2. The units of frequency are usually cycles per second. The SI unit of cycles per second is called a(n) __________.

3. Label the parts of a wave in this drawing. Label the wavelength, the amplitude, the crest, and the origin.

4. The product of wavelength and frequency always equals a(n) __________, the speed of light.

5. Is the following sentence true or false? The wavelength and frequency of light are inversely proportional to each other. __________

6. Light consists of electromagnetic waves. What kinds of visible and invisible radiation are included in the electromagnetic spectrum?

   __________ from __________ to __________

7. When sunlight passes through a prism, the different wavelengths separate into a(n) __________ of colors.

8. Put the visible colors in order of increasing frequency.

   __________ orange __________ violet
   __________ green __________ yellow
   __________ blue __________ red

9. Look at Figure 5.10 on page 139. The electromagnetic spectrum consists of radiation over a broad band of wavelengths. What type of radiation has the lowest frequency? The highest frequency?

   __________ waves __________ rays

10. Atomic Spectra (page 141)

    What happens when an electric current is passed through the gas or vapor of an element?

    __________ move up to __________ quantum level

    Chapter 5 Electrons in Atoms 47
CHAPTER 5, Electrons in Atoms  (continued)

11. Passing the light emitted by an element through a prism gives the
   spectra of the element.

12. Is the following sentence true or false? The emission spectrum of an element
    can be the same as the emission spectrum of another element.
    FALSE

➤ An Explanation of Atomic Spectra (pages 142–143)

13. What is the lowest possible energy of an electron called? GROUND STATE

14. Only electrons moving from  Higher  to
    Lower  energy levels lose energy and emit light.

➤ Quantum Mechanics (pages 281–282)

15. What did Albert Einstein call the quanta of light energy?
    PHOTONS

16. What does de Broglie's equation predict about the behavior of particles?
    WAVELIKE ASPECTS

17. Is the following sentence true or false? Quantum mechanics describes the
    motions of subatomic particles and atoms as waves.
    FALSE (SOMETIMES PARTICLES, SOMETIMES WAVES)

18. According to the Heisenberg uncertainty principle, it is impossible to know
    exactly both the  position  and the  velocity  of a particle
    at the same time.

19. Does the Heisenberg uncertainty principle apply to cars and airplanes?
    NO, ONLY SMALL STUFF
GUIDED PRACTICE PROBLEM

GUIDED PRACTICE PROBLEM 14 (page 140)

14. What is the wavelength of radiation with a frequency of $1.50 \times 10^{13}$ Hz? Does this radiation have a longer or shorter wavelength than red light?

Analyze

Step 1. What is the equation for the relationship between frequency and wavelength? $c = \lambda f$

Step 2. What does $c$ represent and what is its value?

**SPEED OF LIGHT** $3 \times 10^8$ m/s

Step 3. What is the wavelength of red light in cm?

$\lambda = \frac{650 - 700 \text{ nm}}{10^{-7} \text{ m}}$

Calculate

**ASSUMING 675 nm**

Step 4. Solve the equation for the unknown. $\lambda = \frac{c}{f}$.

Step 5. Substitute the known quantities into the equation and solve.

$\frac{2.998 \times 10^8 \text{ m/s}}{1.5 \times 10^{-13} \text{ s}^{-1}} = 2.0 \times 10^5$ m or 200,000 nanometers

Step 6. Compare the answer with the wavelength of red light. Does the given radiation have a wavelength longer or shorter than that of red light?

**RED IS SHORTER, THIS IS IN INFRARED.**

Evaluate

Step 7. Explain why you think your result makes sense. Why is that a question worth?

**Did whoever wrote this ever take an English class?**

Step 8. Are the units in your answer correct? How do you know?

**cause I can write labels & stuff.**