

B

ELECTRONS IN ATOMS

SECTION 13.1 MODELS OF THE ATOM (pages 361–366)

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 Evolution of Atomic Models (pages 361–363)

1. What are the chemical properties of atoms, ions, and molecules related to?

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

| Scientist | Model of Atom |
|------------|---------------|
| Dalton | |
| Thomson | |
| Rutherford | |
| Bohr | |

3. The energy level of an electron is the region around the nucleus where _____.
4. Is the following sentence true or false? The electrons in an atom can exist between energy levels. _____
5. Circle the letter of the term that completes the sentence correctly. A quantum of energy is the amount of energy required to
- move an electron from its present energy level to the next lower one
 - maintain an electron in its present energy level
 - move an electron from its present energy level to the next higher one
6. In general, the higher the electron is on the energy ladder, the _____ it is from the nucleus.

SECTION 13.2 ELECTRON ARRANGEMENT IN ATOMS (pages 367–370)

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 differ from those assigned using the aufbau principle.

► Electron Configurations (pages 367–369)

1. The ways in which electrons are arranged around the nuclei of atoms are called _____.

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

- | | |
|------------------------------------|--|
| _____ 2. aufbau principle | a. When electrons occupy orbitals of equal energy, one electron enters each orbital until all the orbitals contain one electron with parallel spins. |
| _____ 3. Pauli exclusion principle | b. Electrons enter orbitals of lowest energy first. |
| _____ 4. Hund's rule | c. An atomic orbital may describe at most two electrons. |
5. Look at the aufbau diagram, Figure 13.6 on page 367. 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.

| Electron Configurations for Some Selected Elements | | | | | | | |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|---|
| Element | Orbital filling | | | | | 3s | Electron configuration |
| | 1s | 2s | 2p _x | 2p _y | 2p _z | | |
| <input type="text"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 1s ² |
| He | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="text"/> |
| <input type="text"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 1s ² 2s ¹ |
| C | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="text"/> |
| <input type="text"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 1s ² 2s ² 2p ³ |
| O | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="text"/> |
| <input type="text"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 1s ² 2s ² 2p ⁵ |
| Ne | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="text"/> |
| <input type="text"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 1s ² 2s ² 2p ⁶ 3s ¹ |

CHAPTER 13, Electrons in Atoms *(continued)*

- In the shorthand method for writing an electron configuration, what does a superscript stand for?

- In the shorthand method for writing an electron configuration, what does the sum of the superscripts equal?

► Exceptional Electron Configurations (page 370)

- Is the following sentence true or false? The aufbau principle works for every element in the periodic table. _____
- Filled energy sublevels are more _____ than partially filled sublevels.
- 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 13.2, *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 13.3 PHYSICS AND THE QUANTUM MECHANICAL MODEL (pages 372–383)

This section explains how to calculate the wavelength, frequency, or energy of light, given two of these values. It also explains the origin of the atomic emission spectrum of an element.

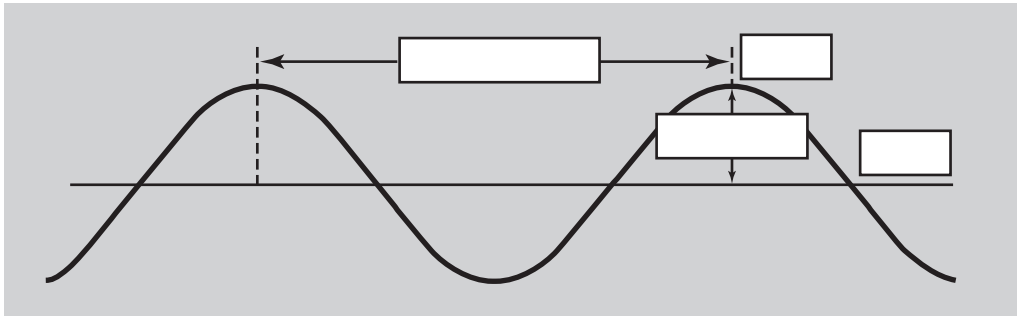
► Light and Atomic Spectra (pages 372–375)

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

2. Match each term describing waves to its definition.

- | | |
|------------------|--|
| _____ amplitude | a. the distance between two crests |
| _____ wavelength | b. the wave's height from the origin to the crest |
| _____ frequency | c. the number of wave cycles to pass a given point per unit of time |

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



4. Is the following sentence true or false? The frequency and wavelength of all waves are inversely related. _____
5. The product of frequency and wavelength always equals a(n) _____, the speed of light.
6. The units of frequency are usually cycles per second. The SI unit of cycles per second is called a(n) _____.
7. When sunlight passes through a prism, the different wavelengths separate into a(n) _____ of colors.
8. Put the visible colors in order from light with the longest wavelength and lowest frequency to light with the shortest wavelength and the highest frequency.
- | | |
|--------------|--------------|
| _____ orange | _____ yellow |
| _____ green | _____ indigo |
| _____ blue | _____ red |
| _____ violet | |
9. Look at Figure 13.10 on page 373. The electromagnetic spectrum consists of radiation over a broad band of wavelengths. What type of radiation has the lowest frequency? The highest frequency?
- _____

10. What happens when an electric discharge is passed through the gas or vapor of an element?

CHAPTER 13, Electrons in Atoms *(continued)*

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

► The Quantum Concept and the Photoelectric Effect (pages 376–379)

13. Planck showed mathematically that the amount of radiant energy (E) absorbed or emitted by a body is _____ to the frequency of the radiation: $E = h \times \nu$.
14. What is a small, discrete unit of energy called?

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

16. What is the photoelectric effect?

17. Is the following sentence true or false? Albert Einstein recognized that there is a threshold value of energy below which the photoelectric effect does not occur. _____

► An Explanation of Atomic Spectra (pages 379–380)

18. What is the lowest energy level of an electron called? _____
19. Only electrons in transition from _____ to _____ energy levels lose energy and emit light.

► Quantum Mechanics (pages 381–382)

20. What does de Broglie's equation describe?

21. What does de Broglie's equation predict?

22. Is the following sentence true or false? The new method of describing the motions of subatomic particles, atoms, and molecules is called quantum mechanics. _____