

# Electrons in Atoms

## Section 5.1 Light and Quantized Energy

In your textbook, read about the wave nature of light.

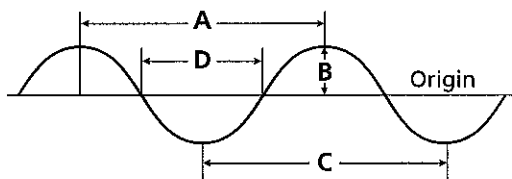
Use each of the terms below just once to complete the passage.

amplitude	energy	frequency	hertz
light	wave	wavelength	speed

Electromagnetic radiation is a kind of **(1)** \_\_\_\_\_ that behaves like a(n) **(2)** \_\_\_\_\_ as it travels through space. **(3)** \_\_\_\_\_ is one type of electromagnetic radiation. Other examples include X rays, radio waves, and microwaves.

All waves can be characterized by their wavelength, amplitude, frequency, and **(4)** \_\_\_\_\_. The shortest distance between equivalent points on a continuous wave is called a(n) **(5)** \_\_\_\_\_. The height of a wave from the origin to a crest or from the origin to a trough is the **(6)** \_\_\_\_\_. **(7)** \_\_\_\_\_ is the number of waves that pass a given point in one second. The SI unit for frequency is the **(8)** \_\_\_\_\_, which is equivalent to one wave per second.

Use the figure to answer the following questions.



9. Which letter(s) represent one wavelength?  
\_\_\_\_\_
10. Which letter(s) represent the amplitude? \_\_\_\_\_
11. If twice the length of A passes a stationary point every second, what is the frequency of the wave?  
\_\_\_\_\_

**Section 5.1** *continued*

*In your textbook, read about the particle nature of light.*

**Circle the letter of the choice that best completes the statement or answers the question.**

- 12.** A(n) \_\_\_\_\_ is the minimum amount of energy that can be lost or gained by an atom.  
 a. valence electron      b. electron      c. quantum      d. Planck's constant
- 13.** According to Planck's theory, for a given frequency,  $\nu$ , matter can emit or absorb energy only in  
 a. units of hertz.      c. entire wavelengths.  
 b. whole-number multiples of  $h\nu$ .      d. multiples of  $\frac{1}{2}h\nu$ ,  $\frac{1}{4}h\nu$ , and so on.
- 14.** The \_\_\_\_\_ is the phenomenon in which electrons are emitted from a metal's surface when light of a certain frequency shines on it.  
 a. quantum      b. Planck concept      c. photon effect      d. photoelectric effect
- 15.** Which equation would you use to calculate the energy of a photon?  
 a.  $E_{\text{photon}} = h\nu \times \text{Planck's constant}$       c.  $E_{\text{photon}} = \frac{1}{2} h\nu$   
 b.  $E_{\text{photon}} = h\nu$       d.  $c = \lambda\nu$

*In your textbook, read about atomic emission spectra.*

**For each statement below, write *true* or *false*.**

- \_\_\_\_\_ **16.** Like the visible spectrum, an atomic emission spectrum is a continuous range of colors.
- \_\_\_\_\_ **17.** Each element has a unique atomic emission spectrum.
- \_\_\_\_\_ **18.** A flame test can be used to identify the presence of certain elements in a compound.
- \_\_\_\_\_ **19.** The fact that only certain colors appear in an element's atomic emission spectrum indicates that only certain frequencies of light are emitted.
- \_\_\_\_\_ **20.** Atomic emission spectra can be explained by the wave model of light.
- \_\_\_\_\_ **21.** The neon atoms in a neon sign emit their characteristic color of light as they absorb energy.
- \_\_\_\_\_ **22.** When an atom emits light, photons having certain specific energies are being emitted.

## Section 5.2 Quantum Theory and the Atom

In your textbook, read about the Bohr model of the atom.

Use each of the terms below to complete the statements.

atomic emission spectrum	electron	frequencies	ground state
higher	energy levels	lower	

- The lowest allowable energy state of an atom is called its \_\_\_\_\_.
- Bohr's model of the atom predicted the \_\_\_\_\_ of the lines in hydrogen's atomic emission spectrum.
- According to Bohr's atomic model, the smaller an electron's orbit, the \_\_\_\_\_ the atom's energy level.
- According to Bohr's atomic model, the larger an electron's orbit, the \_\_\_\_\_ the atom's energy level.
- Bohr proposed that when energy is added to a hydrogen atom, its \_\_\_\_\_ moves to a higher-energy orbit.
- According to Bohr's atomic model, the hydrogen atom emits a photon corresponding to the difference between the \_\_\_\_\_ associated with the two orbits it transitions between.
- Bohr's atomic model failed to explain the \_\_\_\_\_ of elements other than hydrogen.

In your textbook, read about the quantum mechanical model of the atom.

Answer the following questions.

- If you looked closely, could you see the wavelength of a fast-moving car? Explain your answer.  
 \_\_\_\_\_  
 \_\_\_\_\_
- Using de Broglie's equation,  $\lambda = \frac{h}{mv}$  which would have the larger wavelength, a slow-moving proton or a fast-moving golf ball? Explain your answer.  
 \_\_\_\_\_  
 \_\_\_\_\_

**Section 5.2** *continued*

*In your textbook, read about the Heisenberg uncertainty principle.*

For each item in Column A, write the letter of the matching item in Column B.

**Column A****Column B**

- |  |   |
|--|---|
| _____ 10. The modern model of the atom that treats electrons as waves  | a. Heisenberg uncertainty principle     |
| _____ 11. States that it is impossible to know both the velocity and the position of a particle at the same time | b. Schrödinger wave equation            |
| _____ 12. A three-dimensional region around the nucleus representing the probability of finding an electron      | c. quantum mechanical model of the atom |
| _____ 13. Originally applied to the hydrogen atom, it led to the quantum mechanical model of the atom            | d. atomic orbital                       |

**Answer the following question.**

14. How do the Bohr model and the quantum mechanical model of the atom differ in how they describe electrons?

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*In your textbook, read about hydrogen's atomic orbitals.*

**In the space at the left, write the term in parentheses that correctly completes the statement.**

- \_\_\_\_\_ 15. Atomic orbitals (do, do not) have an exactly defined size.
- \_\_\_\_\_ 16. Each orbital may contain at most (two, four) electrons.
- \_\_\_\_\_ 17. All s orbitals are (spherically shaped, dumbbell shaped).
- \_\_\_\_\_ 18. A principal energy has ( $n$ ,  $n^2$ ) energy sublevels.
- \_\_\_\_\_ 19. The maximum number of (electrons, orbitals) related to each principal energy level equals  $2n^2$ .
- \_\_\_\_\_ 20. There are (three, five) equal energy p orbitals.
- \_\_\_\_\_ 21. Hydrogen's principal energy level 2 consists of (2s and 3s, 2s and 2p) orbitals.
- \_\_\_\_\_ 22. Hydrogen's principal energy level 3 consists of (nine, three) orbitals.

### Section 5.3 Electron Configuration

In your textbook, read about ground-state electron configurations.

Use each of the terms below just once to complete the passage.

Aufbau principle	electron configuration	ground-state electron configuration	Hund's rule
lowest	Pauli exclusion principle	spins	stable

The arrangement of electrons in an atom is called the atom's (1) \_\_\_\_\_. Electrons in an atom tend to assume the arrangement that gives the atom the (2) \_\_\_\_\_ possible energy. This arrangement of electrons is the most (3) \_\_\_\_\_ arrangement and is called the atom's (4) \_\_\_\_\_.

Three rules define how electrons can be arranged in an atom's orbitals. The (5) \_\_\_\_\_ states that each electron occupies the lowest energy orbital available. The (6) \_\_\_\_\_ states that a maximum of two electrons may occupy a single atomic orbital, but only if the electrons have opposite (7) \_\_\_\_\_. (8) \_\_\_\_\_ states that single electrons with the same spin must occupy each equal-energy orbital before additional electrons with opposite spins occupy the same orbitals.

Complete the following table.

Element	Atomic Number	Orbitals					Electron Configuration
		1s	2s	2p <sub>x</sub>	2p <sub>y</sub>	2p <sub>z</sub>	
9. Helium							1s <sup>2</sup>
10.	7						
11. Neon		↑↓	↑↓	↑↓	↑↓	↑↓	

**Section 5.3** *continued*

Answer the following questions.

12. What is germanium's atomic number? How many electrons does germanium have?

\_\_\_\_\_

13. What is noble-gas notation, and why is it used to write electron configurations?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

14. Write the ground-state electron configuration of a germanium atom, using noble-gas notation.

\_\_\_\_\_

*In your textbook, read about valence electrons.*

Circle the letter of the choice that best completes the statement or answers the question.

15. The electrons in an atom's outermost orbitals are called  
 a. electron dots.      b. quantum electrons.      c. valence electrons.      d. noble-gas electrons.
16. In an electron-dot structure, the element's symbol represents the  
 a. nucleus of the noble gas closest to the atom in the periodic table.  
 b. atom's nucleus and inner-level electrons.  
 c. atom's valence electrons.  
 d. electrons of the noble gas closest to the atom in the periodic table.
17. How many valence electrons does a chlorine atom have if its electron configuration is  $[\text{Ne}]3s^23p^5$ ?  
 a. 3      b. 21      c. 5      d. 7
18. Given boron's electron configuration of  $[\text{He}]2s^22p^1$ , which of the following represents its electron-dot structure?  
 a.  $\cdot\text{Be}\cdot$       b.  $\cdot\overset{\cdot}{\text{B}}\cdot$       c.  $\overset{\cdot\cdot}{\text{B}}:$       d.  $\overset{\cdot\cdot}{\text{B}}\overset{\cdot\cdot}{\text{e}}$
19. Given beryllium's electron configuration of  $1s^22s^2$ , which of the following represents its electron-dot structure?  
 a.  $\cdot\text{Be}\cdot$       b.  $\cdot\overset{\cdot}{\text{B}}\cdot$       c.  $\overset{\cdot\cdot}{\text{B}}:$       d.  $\overset{\cdot\cdot}{\text{B}}\overset{\cdot\cdot}{\text{e}}$
20. Which electrons are represented by the dots in an electron-dot structure?  
 a. valence electrons      c. only s electrons  
 b. inner-level electrons      d. both a and c