Chapter 5- Electrons in Atoms
Packet o' Problems
+
Study Guide

Scientific Notation

$c = \lambda\upsilon$

$E = h\upsilon$

Electron Configuration

Name _____ Date _____ Class _____

CHAPTER 5 STUDY GUIDE

Electrons in Atoms

Section 5.1 Light and Quantized Energy

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

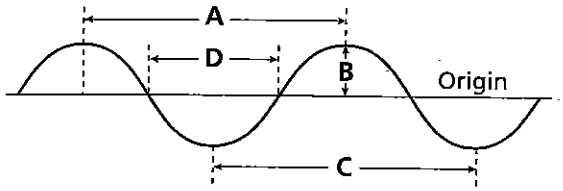
Use each of the terms below just once to complete the passage.

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?

_____

Copyright © Glencoe/McGraw-Hill, a division of The McGraw-Hill Companies, Inc.

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, ν, matter can emit or absorb energy only in

a. units of hertz.

b. whole-number multiples of $h\nu$.

c. entire wavelengths.

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. $E_{\text{photon}} = h\nu \times$ Planck's constant

b. $E_{\text{photon}} = h\nu$

c. $E_{\text{photon}} = \frac{1}{2}h\nu$

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.

Copyright © Glencoe/McGraw-Hill, a division of The McGraw-Hill Companies, Inc.

Name _____ Date _____ Class _____

CHAPTER 5 STUDY GUIDE

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	

1. The lowest allowable energy state of an atom is called its _____.
2. Bohr's model of the atom predicted the _____ of the lines in hydrogen's atomic emission spectrum.
3. According to Bohr's atomic model, the smaller an electron's orbit, the _____ the atom's energy level.
4. According to Bohr's atomic model, the larger an electron's orbit, the _____ the atom's energy level.
5. Bohr proposed that when energy is added to a hydrogen atom, its _____ moves to a higher-energy orbit.
6. 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.
7. 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.

8. If you looked closely, could you see the wavelength of a fast-moving car? Explain your answer.

_____

_____

9. 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.

_____

_____

Copyright © Glencoe/McGraw-Hill, a division of The McGraw-Hill Companies, Inc.

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?

_____

_____

_____

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.

Copyright © Glencoe/McGraw-Hill, a division of The McGraw-Hill Companies, Inc.

Name _____ Date _____ Class _____

CHAPTER 5 STUDY GUIDE

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	$2p_x$	$2p_y$	$2p_z$	
9. Helium							
10.	7						$1s^2$
11. Neon		↑↓	↑↓	↑↓	↑↓	↑↓	

Copyright © Glencoe/McGraw-Hill, a division of The McGraw-Hill Companies, Inc.

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 $[Ne]3s^23p^5$?

a. 3 **b.** 21 **c.** 5 **d.** 7

18. Given boron's electron configuration of $[He]2s^22p^1$, which of the following represents its electron-dot structure?

a. •Be• **b.** •$\dot{B}$• **c.** $\ddot{B}$: **d.** $\ddot{B}e$

19. Given beryllium's electron configuration of $1s^22s^2$, which of the following represents its electron-dot structure?

a. •Be• **b.** •$\dot{B}$• **c.** $\ddot{B}$: **d.** $\ddot{B}e$

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

Copyright © Glencoe/McGraw-Hill, a division of The McGraw-Hill Companies, Inc.

Exponents and Scientific Notation

EXERCISES

Express the following numbers in scientific notation. Keep three digits in your answer.

1. 1 930
2. 262 000
3. 71 400
4. 93 100 000
5. 704
6. 0.0713
7. 0.000 067 2
8. 26.1
9. 0.195
10. 7 790
11. 0.000 001 34
12. 55.600 0
13. 2.940
14. 0.006 21

Express the following numbers in expanded form.

15. 1.00×10^{4}

16. 1.00×10^{-6}

17. 4.38×10^{-5}

18. 3.00×10^{8}

19. 6.626×10^{-34}

20. 6.02×10^{23}

Arithmetic Operations in Scientific Notation

Suppose you need to add or subtract measurements expressed in scientific notation, $M \times 10^n$. The measurements must be expressed in the same powers of 10 and the same units.

Example Problem

Addition and Subtraction Using Scientific Notation

Solve the following problems. Express the answers in scientific notation.

a. 4×10^8 m + 3×10^8 m

b. 4.1×10^{-6} kg − 3.0×10^{-7} kg

c. 4.02×10^6 m + 1.89×10^2 m

Calculate Your Answer

Strategy:

a. If the numbers have the same exponent, n, add or subtract the values of M and keep the same n.

Calculations:

4×10^8 m + 3×10^8 m
$= (4 + 3) \times 10^8$ m
$= 7 \times 10^8$ m

b. If the exponents are not the same, move the decimal to the left or right until they are the same. Then add or subtract M.

4.1×10^{-6} kg − 3.0×10^{-7} kg
$= 4.1 \times 10^{-6}$ kg − 0.30×10^{-6} kg
$= (4.1 - 0.30) \times 10^{-6}$ kg
$= 3.8 \times 10^{-6}$ kg

c. If the magnitude of one number is quite small when compared to the other number, its effect on the larger number is insignificant. The smaller number can be treated as zero.

4.02×10^6 m + 1.89×10^2 m
$= 40\,200 \times 10^2$ m + 1.89×10^2 m
$= (40\,200 + 1.89) \times 10^2$ m
$= 40\,201.89 \times 10^2$ m
$= 4.020\,189 \times 10^6$ m
$= 4.02 \times 10^6$ m

Practice Problems

Solve the following problems. Write your answers in scientific notation.

6. **a.** 5×10^{-7} kg + 3×10^{-7} kg
   b. 4×10^{-3} kg + 3×10^{-3} kg
   c. 1.66×10^{-19} kg + 2.30×10^{-19} kg
   d. 7.2×10^{-12} kg − 2.6×10^{-12} kg
7. **a.** 6×10^{-8} m^2 − 4×10^{-8} m^2
   b. 3.8×10^{-12} m^2 − 1.90×10^{-11} m^2
   c. 5.8×10^{-9} m^2 − 2.8×10^{-9} m^2
   d. 2.26×10^{-18} m^2 − 1.8×10^{-18} m^2

Multiplication and Division Using Scientific Notation

To multiply quantities written in scientific notation, simply multiply the values and units of M. Then add the exponents. To divide quantities expressed in scientific notation, divide the values and units of M, then subtract the exponent of the divisor from the exponent of the dividend. If one unit is a multiple of the other, convert to the same unit.

Example Problem

Find the value of each of the following quantities.

a. $(4 \times 10^3 \text{ kg})(5 \times 10^{11} \text{ m})$

b. $\dfrac{8 \times 10^6 \text{ m}^3}{2 \times 10^{-3} \text{ m}^2}$

Calculate Your Answer

Strategy:

a. Multiply the values of M and add the exponents, n. Multiply the units.

b. Divide the values of M and subtract the exponent of the divisor from the exponent of the dividend.

Calculations:

$(4 \times 10^3 \text{ kg})(5 \times 10^{11} \text{ m}) = (4 \times 5) \times 10^{3+11} \text{ kg·m}$

$= 20 \times 10^{14} \text{ kg·m}$

$= 2 \times 10^{15} \text{ kg·m}$

$\dfrac{8 \times 10^6 \text{ m}^3}{2 \times 10^{-3} \text{ m}^2} = \dfrac{8}{2} \times 10^{6-(-3)} \text{ m}^{3-2}$

$= 4 \times 10^9 \text{ m}$

USING A CALCULATOR

Scientific Notation

Using a calculator simplifies performing arithmetic operations on numbers in scientific notation.

$\dfrac{8 \times 10^6 \text{ kg}}{2 \times 10^{-3} \text{ m}^3}$

Keys	Display
8 EXP 6 ÷	8^06
2 EXP 3 +/− =	4^09

Answer
$4 \times 10^9 \text{ kg/m}^3$

$4.0 \times 10^{-6} \text{ kg} - 3.0 \times 10^{-7} \text{ kg}$

Keys	Dis
4.0 EXP 6 +/− −	4.0^−06
3.0 EXP 7 +/− =	3.7^−06

Answer
$3.7 \times 10^{-8} \text{ kg}$

Practice Problems

Find the value of each of the following quantities.

9. a. $(2 \times 10^4 \text{ m})(4 \times 10^8 \text{ m})$

b. $(3 \times 10^4 \text{ m})(2 \times 10^6 \text{ m})$

c. $(6 \times 10^{-4} \text{ m})(5 \times 10^{-8} \text{ m})$

d. $(2.5 \times 10^{-7} \text{ m})(2.5 \times 10^{16} \text{ m})$

10. a. $\dfrac{6 \times 10^8 \text{ kg}}{2 \times 10^4 \text{ m}^3}$

b. $\dfrac{6 \times 10^8 \text{ kg}}{2 \times 10^{-4} \text{ m}^3}$

c. $\dfrac{6 \times 10^{-8} \text{ m}}{2 \times 10^4 \text{ s}}$

d. $\dfrac{6 \times 10^{-8} \text{ m}}{2 \times 10^{-4} \text{ s}}$

11. a. $\dfrac{(3 \times 10^4 \text{ kg})(4 \times 10^4 \text{ m})}{6 \times 10^4 \text{ s}}$

b. $\dfrac{(2.5 \times 10^6 \text{ kg})(6 \times 10^4 \text{ m})}{5 \times 10^{-2} \text{ s}^2}$

Wave Calculations

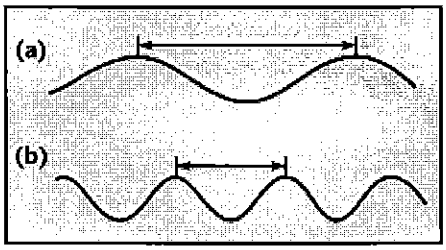
Use the formula **wave speed = wavelength x frequency** ($c = \lambda\upsilon$) to complete the following problems.

1. After careful analysis, an electromagnetic wave is found to have a frequency of 7.8×10^{6} Hz. What is the speed of the wave?

2. Objects get their colors from reflecting only certain wavelengths when hit with white light. Light reflected from a green leaf is found to have a wavelength of 4.90×10^{-7} m. What is the frequency of the light? The speed of light (c) = 3.00×10^{8} m/s.

3. X-rays can penetrate body tissues and are widely used to diagnose and treat disorders of internal body tissues. What is the wavelength of an X-ray with a frequency of 2.61×10^{18} Hz?

4. While an FM radio station broadcasts at a frequency of 101.9 MHz (1.019×10^{8} Hz), an AM station broadcasts at a frequency of 660 kHz (6.60×10^{5} Hz). What are the wavelengths of the broadcasts? Which of the 2 drawings below corresponds to the FM station? To the AM station?



Name: Period:

Worksheet- Electromagnetic Radiation

Fill in the following table dealing with wavelength, frequency, and energy for electromagnetic waves. All travel at the speed of light. Show your work for each on the back of this page.

Velocity (m/s)	Wavelength (m)	Frequency (Hz)	Energy (J)
		5.80×10^{14}	
			4.75×10^{-19}
	3.07		
		5.20×10^{14}	
			3.00×10^{-19}
	4.75×10^{-7}		
			3.00×10^{-18}
		3.95×10^{14}	
	7.50×10^{-10}		
		9.55×10^{7}	
			5.50×10^{-15}

ELECTRON CONFIGURATION (LEVEL ONE)

Name _____

Electrons are distributed in the electron cloud into principal energy levels (1, 2, 3, ...), sublevels (s, p, d, f), orbitals (s has 1, p has 3, d has 5, f has 7) and spin (two electrons allowed per orbital).

Example: Draw the electron configuration of sodium (atomic #11).

Answer: $1s^2$ $2s^2$ $2p^6$ $3s^1$

Draw the electron configurations of the following atoms.

1. Cl

2. N

3. Al

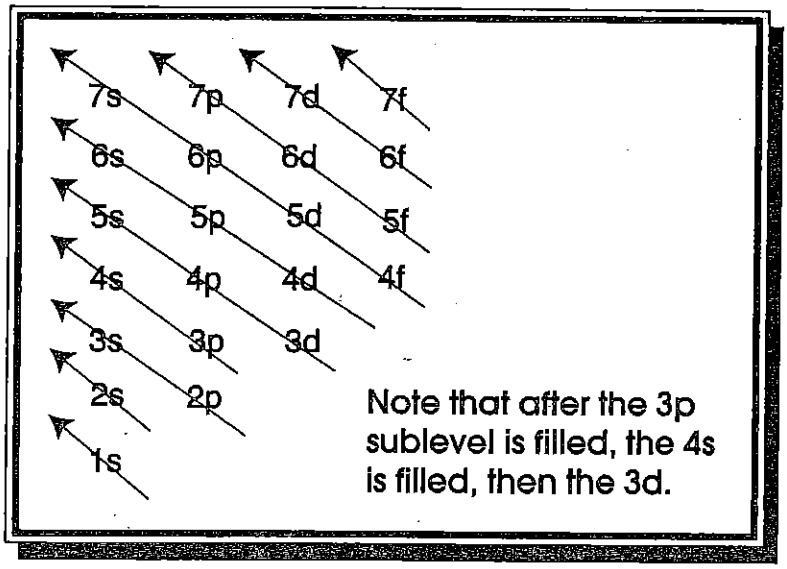
4. O

©Instructional Fair, Inc.

ELECTRON CONFIGURATION (LEVEL TWO)

Name _____

At atomic number greater than 18, the sublevels begin to fill out of order. A good approximation of the order of filling can be determined using the diagonal rule.



Draw the electron configurations of the following atoms.

1. K

2. V

3. Co

4. Zr

©Instructional Fair, Inc.

Electron Configurations Worksheet

Write the complete ground state electron configurations for the following:

1) lithium _____

2) oxygen _____

3) calcium _____

4) titanium _____

5) rubidium _____

6) lead _____

7) erbium _____

Write the abbreviated ground state electron configurations for the following:

8) helium _____

9) nitrogen _____

10) chlorine _____

11) iron _____

12) zinc _____

13) barium _____

14) polonium _____

© 2006 Cavalcade Publishing. All Rights Reserved

Electron Configuration Practice Worksheet

In the space below, write the unabbreviated electron configurations of the following elements:

1) sodium _____

2) iron _____

3) bromine _____

4) barium _____

5) neptunium _____

6) cobalt _____

7) silver _____

8) tellurium _____

9) radium _____

10) lawrencium _____

Determine what elements are denoted by the following electron configurations:

11) $1s^2 2s^2 2p^6 3s^2 3p^4$ _____

12) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^1$ _____

13) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 4d^{10} 4p^5$ _____

14) $1s^2 2s^2 2p^6 3s^2 3p^5$ _____

Need homework help? Visit www.chemfiesta.com !

Write the shortcut electron configuration for each

1) sodium _____

2) iron _____

3) bromine _____

4) barium _____

5) neptunium _____

6) cobalt _____

7) silver _____

8) tellurium _____

9) radium _____

10) lawrencium _____

Determine what elements are denoted by the following electron configurations:

11) $(Ne)3s^2 3p^4$ _____

12) $(Kr)5s^1$ _____

13) $[Kr]\ 5s^2 4d^{10} 5p^3$ _____

14) $[Xe]\ 6s^2 4f^{14} 5d^6$ _____

15) $[Rn]\ 7s^2 5f^{11}$ _____

Need homework help? Visit www.chemfiesta.com !