Name: Key 2016

Chapter 7 Study Guide

A. VOCABULARY

Select the term in Column B that matches the expression in column A.

Column A

J **1.** cannot know both the velocity and position of an electron simultaneously
B **2.** noble gas
E **3.** orbitals of equal energy are each occupied by one electron of the same spin before any orbital is occupied by a second electron
F **4.** cobalt
C **5.** an electron occupies the lowest energy orbital it can
G **6.** tin
D **7.** noble-gas notation
A **8.** every electron in an atom has a unique set of quantum numbers
I **9.** orientation of an orbital
H **10.** shape of an orbital

Column B

a. Pauli Exclusion Principle
b. krypton
c. Aufbau Principle
d. $[Ne]3s^1$
e. Hund's Rule
f. fourth-period element
g. fifth-period element
h. angular momentum quantum number
i. magnetic quantum number
j. Heisenberg Uncertainty Principle

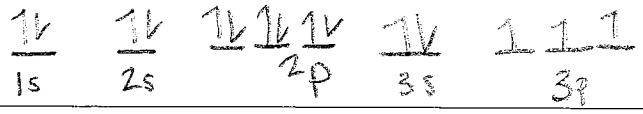
B. The electron configuration of phosphorus is $1s^2 2s^2 2p^6 3s^2 3p^3$.

1. How many electrons are present in an atom of phosphorus? 15

How did you arrive at that answer? add # of electrons

2. What is the atomic number for phosphorus? 15

3. Write the orbital notation for phosphorus.



C. Write the electron configuration for the element magnesium, which has an atomic number of 12. $1s^2 2s^2 2p^6 3s^2$

D. Complete the chart by supplying the missing information.

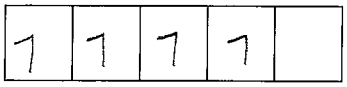
Element	Atomic Number	Electron Configuration	Noble-Gas Configuration
Cobalt	27	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^7$	$[Ar]4s^2 3d^7$
Zinc	30	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10}$	$[Ar]4s^2 3d^{10}$
Arsenic	33	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^3$	$[Ar]4s^2 3d^{10} 4p^3$
Krypton	36	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6$	$[Ar]4s^2 3d^{10} 4p^6$
Zirconium	40	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^2$	$[Kr]5s^2 4d^2$
Rhodium	45	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^7$	$[Kr]5s^2 4d^7$
Lithium	3	$1s^2 2s^1$	N.A.
Boron	5	$1s^2 2s^2 2p^1$	N.A.
Neon	10	$1s^2 2s^2 2p^6$	N.A.
Aluminum	13	$1s^2 2s^2 2p^6 3s^2 3p^1$	$[Ne]3s^2 3p^1$
Chlorine	17	$1s^2 2s^2 2p^6 3s^2 3p^5$	$[Ne]3s^2 3p^5$
Titanium	22	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^2$	$[Ar]4s^2 3d^2$
Iron	26	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6$	$[Ar]4s^2 3d^6$

E. Write *true* or *false* for each of the following statements.

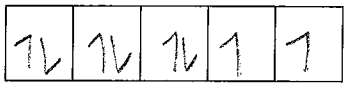
1. Lines and arrows are used to indicate electron configuration in **electron-configuration notation.** F (orbital diagram)
2. The **spin quantum number (electron spin)** of an electron can have only two possible values. T ($+\frac{1}{2}$ & $-\frac{1}{2}$)
3. The **ground-state electron configuration** is the highest-energy arrangement of electrons for an element. F (lowest) high = excited state
4. According to the **Aufbau principle**, an electron occupies the lowest-energy orbital that will receive it. T
5. It requires less energy for two electrons to pair up in the **4*s* sublevel** than for one to occupy a 3*d* sublevel. T

F. Orbital Notation

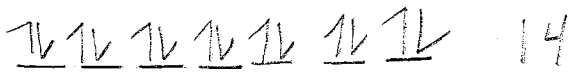
1. The boxes represent the d sublevel of a given main energy. Use Hund's rule and arrows to show how four electrons would fill the sublevel.



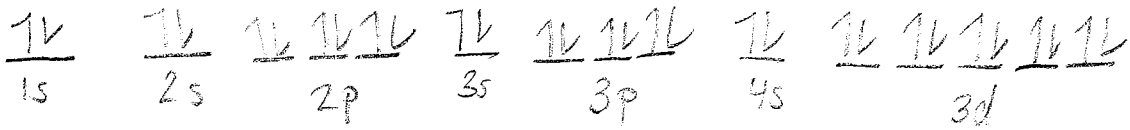
2. Show how eight electrons would fill the same sublevel.



3. What is the maximum amount of electrons that can fill the f sublevel? Draw a figure that represents your answer.



4. Write the orbital notation for zinc.



5. Determine the number of valence electrons for argon.

Practice Problems

1. List the 7 main types of electromagnetic radiation.

1. gamma
2. x-ray
3. ultraviolet
4. visible
5. infrared
6. micro
7. radio

2. List the colors of light in the visible spectrum in order of increasing frequency.

1. red — lowest frequency
2. orange
3. yellow
4. green
5. blue
6. violet — highest frequency

3. Determine the frequency of light with a wavelength of 4.257×10^{-7} cm.

$C = \lambda\nu$

$4.257\times10^{-7}\ cm \times \frac{1m}{100cm}$

$3\times10^{8} = (4.257\times10^{-9})\nu$

$7.047\times10^{17}\ Hz = \nu$

4. Determine the energy in joules of a photon whose frequency is 3.55×10^{17} Hz.

$E = h\nu$

$E = (6.63\times10^{-34}\ J\cdot s)(3.55\times10^{17}\ Hz)$

$E = 2.35\times10^{-16}\ J$

5. When sodium is heated, a yellow spectral line whose energy is 3.37×10^{-19} J/photon is produced.

a. What is the frequency of this light?

$E = h\nu$ $\quad 3.37\times10^{-19}\ J = (6.63\times10^{-34}\ J\cdot s)(\nu)$

$\nu = 5.08\times10^{14}\ Hz$

b. What is its wavelength?

$3\times10^{8} = \lambda(5.08\times10^{14})$

$\lambda = 5.91\times10^{-7}\ m$

6. A hydrogen atom in its ground state absorbs electromagnetic radiation with a wavelength of 102.6 nm. Calculate the energy level (n) of the resulting excited state.

$\Delta E = R_H\left(\frac{1}{n_i^2} - \frac{1}{n_f^2}\right)$

① $102.6nm \times \frac{1m}{1\times10^{9}nm} = 1.026\times10^{-7}\ m$

② $3\times10^{8} = (1.026\times10^{-7})\nu$ $\quad \nu = 2.924\times10^{15}$

③ $E = h\nu = (6.63\times10^{-34})(2.924\times10^{15})$

$= 1.939\times10^{-18}\ J = +\Delta E$ (absorb)

④ $1.939\times10^{-18} = 2.18\times10^{-18}\left(\frac{1}{1^2} - \frac{1}{n_f^2}\right)$

$0.8893 = 1 - \frac{1}{n_f^2}$

$-0.1107 = -\frac{1}{n_f^2}$

$0.1107\,n_f^2 = 1$

$4\ n_f^2 = 9.03$

$n_f = 9$

Additional practice problems in your textbook: page 304 #10, 30, 40, 100a

Multiple Choice Practice

Circle the letter of the best answer.

1. Which of the following statements is true?
   a. Atoms of each element have their own distinct electron configurations.
   b. The 1*f* orbital has the lowest energy of all the orbitals.
   c. The Aufbau principle explains why two electrons of opposite spins can occupy the same orbital.
   d. The quantum model of the atom describes only the arrangement of hydrogen atoms.

2. Electrons behave in the way explained by Hund's rule so that
   a. atoms of each element have their own particular shapes.
   b. electrons assume the highest possible energies.
   c. repulsion between electrons is minimized.
   d. the *d* sublevel fills before the *p* sublevel.

3. Which of the following is the electron configuration for oxygen (atomic number 8)?
   a. $1s^2 2s^2 3s^2$
   b. $1s^2 2s^2 2p^4$
   c. $1s^1 2s^1 2p^3 3s^1 3p^2$
   d. $1s^2 2s^2 3s^2 4s^2$

4. Sulfur has the electron configuration $1s^2 2s^2 2p^6 3s^2 3p^4$. That means that sulfur has
   a. 16 electrons
   b. 16 neutrons
   c. an atomic number of 16
   d. both a and c. (depends on interpretation)

5. The Pauli exclusion principle allows
   a. electrons to enter sublevels without previous sublevels being filled.
   b. for using noble-gas configurations for Group 18 elements.
   c. electrons to pair in an orbital as long as their spins are opposite.
   d. for using the configuration for Ar to describe noble gases.

6. Which of the following statements is true?
   a. The symbol for nitrogen is used in noble-gas notation.
   b. Hund's rule is followed for writing the notations of atoms of all elements.
   c. Atoms deviate from predicted configurations in order to have the lowest possible energy.
   d. Oxygen is a noble gas.

7. The noble-gas notation $[Ne]3s^2 3p^3$ indicates that
   a. the element is a noble gas.
   b. the element's atomic number is 3.
   c. the element's atomic number is 15.
   d. the structure of the atom deviates from Hund's rule.

8. The noble-gas notation [Ar]$4s^2 3d^2$ indicates that the element
   a. is in the fifth period of the periodic table.
   b. is a fourth-period element.
   c. has 11 orbitals that contain electrons.
   d. has an electron configuration that follows Hund's rule.

Quantum Numbers Practice

1. Write the complete set of quantum numbers that represent the valence electrons for calcium.

[Ar] $4s^2$

$n = 4$ $\quad m_l = 0$

$l = 0$ $\quad m_s = +1/2, -1/2$

2. Write the possible quantum numbers that represent the last (outermost) electron in bromine. ~~Include~~ all possible values. [Ar] $4s^2 3d^{10} 4p^5$

$n = 4$ $\quad m_l = -1, 0, +1$

$l = 1$ $\quad m_s = +1/2, -1/2$

3. Fill in the blanks:
   a. The sublevel with the quantum numbers n=4 and l=2 is d.
   b. The m_l values for a d orbital are -2, -1, 0, +1, +2.
   c. The possible values of l for the shell where n=4 are 0, 1, 2, 3. (s, p, d, f)
   d. The maximum number of electrons where n=4 and l=1 is 6.
   e. The lowest value of n for which a d sublevel can occur is n = 3.
   f. The number of orbitals that exist when n=3 and l=2 is 5.