ChemQuest 18

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Electron Configurations

Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Hour: \_\_\_\_\_

# **Information**: Energy of Sublevels

Each sublevel has a different amount of energy. For example, orbitals in the 3p sublevel have more energy than orbitals in the 2p sublevel. The following is a list of the sublevels from lowest to highest energy:

1s, 2s, 2p, 3s, 3p, 4s, 3d, 4p, 5s, 4d, 5p, 6s, 4f, 5d, 6p, 7s, 5f, 6d…

To help you, here is the above list with the orbitals included. Recall that each blank represents an orbital:

1s \_, 2s \_, 2p \_ \_ \_, 3s \_, 3p \_ \_ \_, 4s \_, 3d \_ \_ \_ \_ \_ , 4p \_ \_ \_ , 5s \_, 4d \_ \_ \_ \_ \_ , 5p \_ \_ \_ , 6s \_, 4f \_ \_ \_ \_ \_ \_ \_

Note that d and f sublevels appear to be out of place. This is because they have extra high energies. For example, the 3d sublevel has a higher energy than a 4s sublevel and the 4f sublevel has a higher energy than the 6s sublevel.

When electrons occupy orbitals, they try to have the lowest amount of energy possible. (This is called the ***Aufbau Principle***.) An electron will enter a 2s orbital only after the 1s sublevel is filled up and an electron will enter a 3d orbital only after the 4s sublevel is filled. Recall that only two electrons can fit in each orbital. (This is called the ***Pauli Exclusion Principle***.) When two electrons occupy the same orbital they must spin in opposite directions—one clockwise and the other counterclockwise.

# **Critical Thinking Questions**

1. a) How many electrons would an atom need to have before it can begin filling the 3s sublevel?

b) What is the first element that has enough electrons to have one in the 3s sublevel? (Use your periodic table.)

1. a) How many electrons would an atom need to have before it can begin filling the 3d sublevel?

b) What is the first element that has enough electrons to begin placing electrons in the 3d sublevel?

1. How many electrons does the element boron have? (use your periodic table)
2. Below are two different ways of depicting the electrons in an atom.

1s

2s

2p

**Orbital diagram**: **Electron configuration**: 1s22s22p1

1. In the orbital diagram, what do the arrows stand for?
2. What do the little superscripts stand for in the electron configuration?
3. Both of the diagrams represent the same element. Name the element.
4. For each of the following electron diagrams decide whether it is an “orbital diagram” or an “electron configuration” and name the element.

a) 1s22s22p63s23p4 This is an \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and the element is \_\_\_\_\_\_\_\_\_\_.

electron configuration OR orbital diagram? name the element

1s

2s

2p

b) This is an \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and the element is \_\_\_\_\_\_\_\_\_\_.

electron configuration OR orbital diagram? name the element

c) This is an \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and the element is \_\_\_\_\_\_\_\_\_\_.

1s

2s

2p

electron configuration OR orbital diagram? name the element

1s

2s

2p

d) This is an \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and the element is \_\_\_\_\_\_\_\_\_.

electron configuration OR orbital diagram? name the element

# **Information**: Hund’s Rule

Look at the orbital diagram from question 5b. Hopefully you identified the element as carbon. The following diagram has six arrows just like carbon’s from 5b:

It is technically **wrong** to put the electrons like this. Electrons like to spread out when going into “p” orbitals.

1s

2p

2s

Look again at oxygen’s orbital diagram from question 5d. The following diagram is a **wrong** way to draw oxygen’s orbital diagram:

It is technically **wrong** to put the electrons like this. Electrons like to spread out when going into “p” orbitals.

2p

2s

1s

1s

This is **correct**. Electrons like to spread out when going into “p” orbitals. They also try to spin “up” whenever they can.

2p

2s

This is **correct**. When electrons have to occupy the same orbital then they will spin in opposite directions.

# **Critical Thinking Questions**

1. *Hund’s Rule* is the name of the rule that summarizes the above information section about electrons. Which of the following is the best statement of *Hund’s Rule*?
2. Electrons prefer to pair up to occupy the same orbital whenever possible.
3. Whenever possible, electrons will be unpaired (in separate orbitals) with parallel spins.
4. The following orbital diagram is drawn incorrectly. Redraw it correctly.

3p

3s

2p

2s

1s

1. Each of the following orbital diagrams is incorrect. Redraw them correctly.

Incorrect Correct

3p

3s

2p

2s

1s

3p

2p

3s

2s

1s

3p

3s

2p

2s

1s

1. Translate the following “electron configurations” into “orbital diagrams” (use arrows).

Electron Configuration Orbital Diagram (use arrows)

a) 1s2 2s2 2p6 3s2 3p2

* 1. 1s2 2s2 2p6 3s1
  2. 1s2 2s2 2p5

1. Look at the electron configurations from question 9. Write the name of each element.
2. The element from question 9a is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

aluminum, silicon, phosphorus, OR fluorine?

1. The element from question 9b is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
2. The element from question 9c is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
3. Write electron configurations (no arrows required) for the following elements. The first one is done for you.
4. Phosphorus 1s2 2s2 2p6 3s2 3p3 (phosphorus has 15 electrons)
5. Neon
6. Aluminum
7. Sodium
8. The following electron configurations are incorrect. Fix them. (The first is done for you)

Wrong Electron Configuration Correct Electron Configuration

a) 1s2 2s23s23p2 1s2 2s2 2p4 (this is the correct way to do 8 electrons)

First, add up the electrons. There are 8 here.

* 1. 1s2 2s2 2p5 3s2
  2. 1s2 2s4 2p8
  3. 1s2 2s2 3s2 3p6

1s

2s

2p

1. Nitrogen’s orbital diagram is: Nitrogen as 3 “unpaired electrons” and 4 “paired electrons.”

Define the term unpaired electron:

1. How many unpaired electrons does oxygen have?