



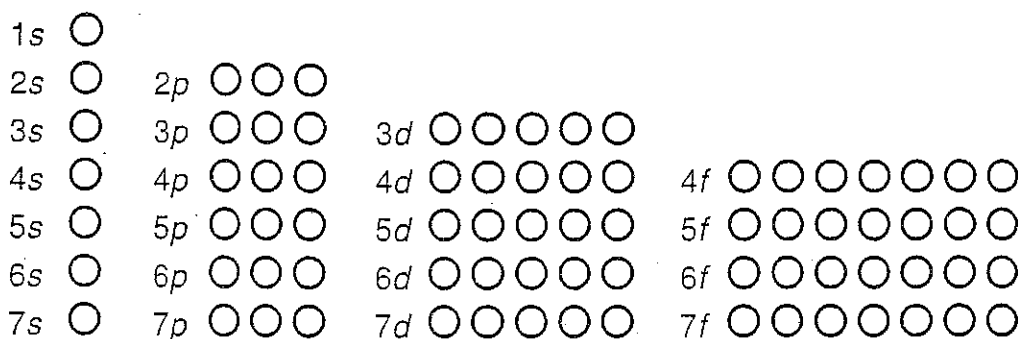
# Understanding Electron Configuration

The electrons in an atom occupy distinct *energy levels*. These energy levels are subdivided into *sublevels*, differentiated by the letters *s*, *p*, *d* and *f*. Within each sublevel, there are a specific number of *orbitals*, each capable of accommodating two electrons.

To determine the electron configuration of any atom, start with the lowest energy orbital, and fill the orbitals in the order of increasing energy as follows.

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

The diagram below can be used to help you write electron configurations of atoms. The electrons are placed in the circles which represent atomic orbitals. An electron is represented by an arrow. Each orbital can accommodate a maximum of two electrons.



When all the electrons of a given element have been placed according to the increasing energy of the orbitals, the electron configuration can be written out as illustrated for chlorine.

Chlorine, Cl

Atomic Number = 17.  $1s^2 2s^2 2p^6 3s^2 3p^5$

## Objectives

1. *Formulate* the electron configurations of many elements.
2. *Relate* the chemical behavior of elements to their electron configurations.
3. *Relate* electron configurations of elements to the periodic table.

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### Materials

#### Apparatus

multiple copies of the electron configuration grid  
periodic table  
chart of common ions  
scissors

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### Prelab

1. Read the introduction and the procedure before you begin.
2. Answer prelab questions 1–4 on the Report Sheet.

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### Procedure

1. You will be a member of a group for this experiment. Each person in the group will be assigned between 12 and 16 elements. The whole group will be responsible for a total of 48 elements.
2. For each of the elements you have been assigned, you need to complete the electron configuration grid.
3. Cut the electron configuration grid into pieces so that only one element is on each piece of paper.
4. Using all 48 elements, the members of the group will work together to answer the Analysis and Conclusion questions.

**Report Sheet**

# **Understanding Electron Configuration**

**■ Prelab Questions**

1. Distinguish between the following terms: energy level, sub-level, and orbital.

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2. In each of the following pairs, indicate which is the higher energy orbital.

- a.  $1s$  or  $3s$ ?
- b.  $4s$  or  $3d$ ?
- c.  $5f$  or  $6s$ ?

3. What is the maximum number of electrons possible for the following energy levels?

- a. 1st energy level
- b. 2nd energy level
- c. 3rd energy level
- d. 4th energy level

4. Write in your own words the purpose of this experiment.

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## ■ Analysis and Conclusions

1. Find *all* of the elements that end with a single *s* electron (either  $1s$ ,  $2s$ ,  $3s$ ,  $4s$ ,  $5s$ ,  $6s$ , or  $7s$ ).

a. What are the symbols of these elements, in increasing atomic number order?

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b. Use the chart of the ions to find out the charge on as many of these elements as you can find. What are the charges?

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c. Can your group explain any connection between the charge and the electron configuration of these elements?

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2. Find all of the elements that *end* with two *s* electrons. Be sure that you have only the elements whose last electron was that second *s* electron.

a. What are the symbols of these elements, in increasing atomic number order?

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b. Use the chart of the ions to find out the charge on as many of these elements as you can find. What are the charges?

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c. Explain any connection between the charge and the electron configuration of these elements.

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d. Explain why helium does not seem to fit in with the rest of the elements in this group.

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3. Find all of the elements that have two *s* electrons and six *p* electrons in their outside energy level.

a. What are the symbols of these elements, in increasing atomic number order?

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b. Look on your periodic table and find the elements on this list. Where are they located?

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c. Explain why helium is found on the periodic table with these elements, but does not end with the same electron pattern.

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4. Find all of the elements that end with *d* electrons.

a. What are the symbols of these elements, in increasing atomic number order?

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b. Look on your periodic table and find the elements on this list. Where are they located?

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5. Find all of the elements that end with  $f$  electrons.

a. What are the symbols of these elements, in increasing atomic number order?

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b. Look on your periodic table and find the elements on this list. Where are they located?

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6. Find all of the elements that have their outside electrons in the third energy level.

a. What are the symbols of these elements, in increasing atomic number order?

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b. Look on your periodic table and find the elements on this list. Where are they located?

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7. Find all of the elements that have their outside electrons in the fourth energy level.

a. What are the symbols of these elements, in increasing atomic number order?

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b. Look on your periodic table and find the elements on this list. Where are they located?

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8. A scrap of paper with the electron configuration of an element was picked up off the floor. It was incomplete, but the last thing listed was  $6s^2 6p^4$ . What is this element's complete electron configuration?

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9. Look up on your chart of common ions for elements that have a charge of  $1^-$ .

a. List only the ions of individual elements, not the polyatomic ions.

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b. Look at the electron configuration of these elements. Do you see anything in common among these elements?

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10. Look up on your chart of common ions for elements that have a charge of  $2^-$ .

a. List only the ions of individual elements, not the polyatomic ions.

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b. Look at the electron configuration of these elements. Do you see anything in common among these elements?

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 **Synthesis**

1. All of the questions above have been designed to make you think about the connections among electron configurations, the periodic table, and chemical behavior. On a separate piece of paper, write a clear essay summarizing these connections. Use information in your textbook and other resources to add to what you learned in this exercise. The supporting information should focus primarily on the chemical properties of the elements.
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