Name _____ Class _____ Date _____

SECTION 1 Electrons and Chemical Bonding

BEFORE YOU READ

After you read this section, you should be able to answer these questions:

- What is chemical bonding?
- What are valence electrons?
- How do valence electrons affect bonding?

National Science Education Standards

PS 1b, 1c

What Is a Chemical Bond?

All things are made of atoms. A few substances are made of single atoms, but most are made of two or more atoms joined together. **Chemical bonding** is the joining of atoms to form a new substance. The bond that forms when two atoms join is called a **chemical bond**. Chemical bonds form when electrons in atoms interact. Atoms can gain, lose, or share electrons to form a chemical bond. ☑

In some cases, the atoms that join together are atoms of the same element. Oxygen gas, for example, is made of two oxygen atoms bonded together. In other cases, atoms of different elements bond. For example, hydrogen and oxygen atoms bond to form water.

STUDY TIP

Clarify Concepts Take turns reading this section out loud with a partner. Stop to discuss ideas that seem confusing.

READING CHECK

1. Explain What can happen to electrons in an atom when a chemical bond forms?

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ELECTRONS IN ATOMS

Remember that electrons are found outside the nucleus in layers called energy levels. Each energy level can hold a certain number of electrons. The first energy level is closest to the nucleus. It can hold up to two electrons. The second energy level can hold up to eight electrons. The third energy level can also hold up to eight electrons. ☑

READING CHECK

2. Describe Where are electrons found in an atom?

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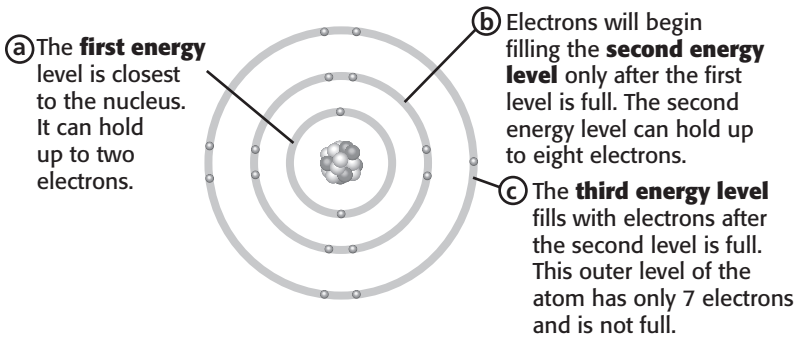
Electron Arrangement in an Atom of Chlorine



Which Electrons Affect Bonding?

Atoms form chemical bonds when their electrons interact with one another. However, not all of the electrons in an atom interact to form bonds. In most cases, only the electrons in the outermost energy level are able to form bonds. Electrons in the outermost energy level are called **valence electrons**. An atom can form different kinds of bonds depending on how many valence electrons it has. ☑

READING CHECK

3. Explain Where are the valence electrons found in an atom?

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DETERMINING THE NUMBER OF VALENCE ELECTRONS

The *atomic number* of an element tells you how many protons are in an atom of the element. No two elements have the same number of protons in their atoms. As a result, no two elements have the same atomic number. The number of protons in an atom equals the number of electrons in the atom. Therefore, the atomic number also tells how many electrons are found in an atom of an element.

You can use an element's atomic number to learn how many valence electrons its atoms have. In order to do this, you need to draw a model of the atom. Remember that valence electrons are in the outermost level. For example, the figures below show models of two atoms.

Model of an Oxygen Atom **Model of a Sodium Atom**

In the illustration above, the figure on the left shows a model of an atom of oxygen. Oxygen's atomic number is 8. Therefore, its atoms have 8 electrons in them. The first energy level holds 2 electrons. The second, outermost energy level has 6 electrons in it. Therefore, oxygen has 6 valence electrons.

In the illustration above, the figure on the right shows a model of a sodium atom. Sodium's atomic number is 11. Its atoms have 11 electrons in them. The first energy level holds 2 electrons. The second energy level holds 8 electrons. The third, outermost energy level holds 1 electron. Therefore, sodium has 1 valence electron.

Math Focus

4. Determine The atomic number of carbon is 6. How many protons does an atom of carbon have? How many electrons?

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_____

STANDARDS CHECK

PS 1b Substances react chemically in characteristic ways with other substances to form new substances (compounds) with different characteristics. In chemical reactions, the total mass is conserved. Substances are often placed in categories or groups if they react in similar ways; metals is an example of such a group.

Word Help: chemical
of or having to do with properties or actions of substances

Word Help: reaction
a response or change

5. Determine When oxygen reacts, how many more electrons are needed to fill its outermost energy level?

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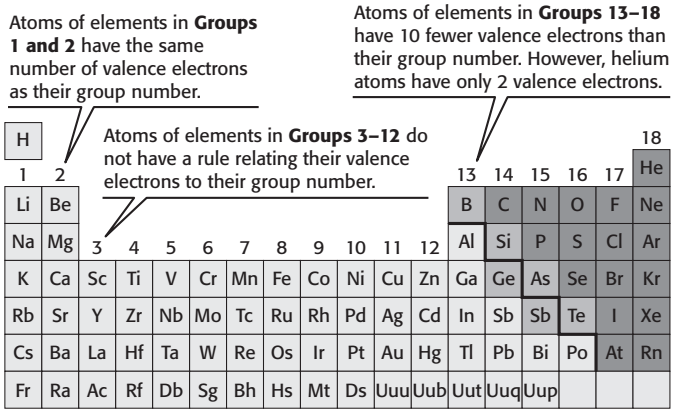
USING THE PERIODIC TABLE TO FIND VALENCE ELECTRONS

You can also use the periodic table to find the number of valence electrons in an atom. Each column in the table is a group. The atoms of all of the elements in a group have the same number of valence electrons. The only exception to this rule is helium. Helium has two valence electrons. All of the other atoms in its group have eight valence electrons.

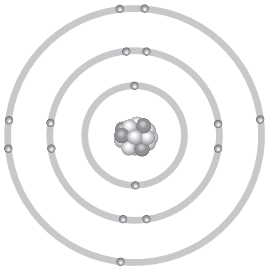


Why Do Atoms Bond?

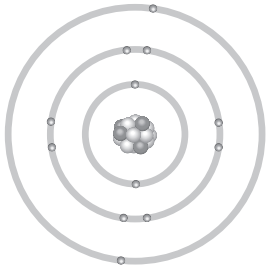
Some atoms form bonds easily. Others don't. How an atom bonds depends on how many valence electrons it has. An atom forms a bond with another atom in order to complete, or fill, its outermost energy level. An atom is most stable when its outermost energy level is full. ☑

The atoms in Group 18 (at the far right) have full outermost energy levels. Therefore, they do not usually form bonds. However, atoms in the other groups have outermost energy levels that are not full. These atoms fill their outermost energy levels by forming bonds. For most atoms, eight electrons will fill the outermost energy level

Filling Outermost Energy Levels



Sulfur An atom of sulfur has six valence electrons. It can have eight valence electrons by sharing two electrons with or gaining two electrons from other atoms.



Magnesium An atom of magnesium has two valence electrons. It can have a full outer level by losing two electrons. The second energy level becomes the outermost energy level and has eight electrons.

Math Focus

6. Analyze Data Use the periodic table to figure out how many valence electrons the elements in Group 16 have.

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READING CHECK

7. Explain Why do atoms bond with one another?

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TAKE A LOOK

8. Apply Concepts Calcium (Ca) is in the same group as magnesium. Does it tend to gain or lose electrons when it bonds?

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Name _____ Class _____ Date _____

Section 1 Review

NSES **PS 1b, 1c**

SECTION VOCABULARY

chemical bonding the combining of atoms to form molecules or ionic compounds **chemical bond** an interaction that holds atoms or ions together	**valence electron** an electron that is found in the outermost shell of an atom and that determines the atom's chemical properties

1. Identify How do atoms form chemical bonds?

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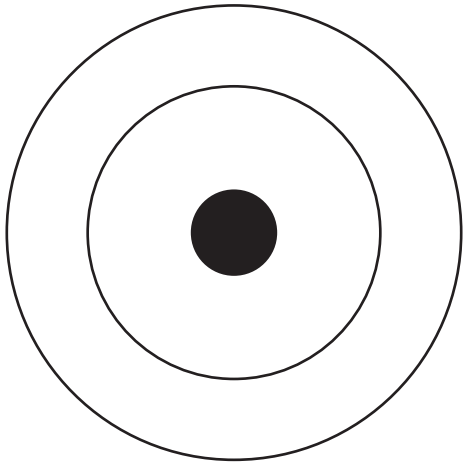
2. Use Models Fluorine (F) is an atom with two electrons in its innermost energy level and seven in its outermost level. Draw the electrons around the nucleus. Color the valence electrons in a different color.



3. Apply Concepts How can an atom that has seven valence electrons complete its outermost level?

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4. Apply Concepts Magnesium (Mg) has two electrons in its outermost energy level. Oxygen (O) has six. How can a Mg atom bond with an O atom?

_____

5. Interpret Graphics Each box in the periodic table contains an element symbol and the element's atomic number. Using the box below, answer the questions about sulfur (S) next to the box.

16
S

How many protons does an atom of sulfur have? _____

How many electrons does an atom of sulfur have? _____