

CHAPTER 10 Chemical Compounds

SECTION 1

Ionic and Covalent Compounds

BEFORE YOU READ

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

- What gives a compound its physical properties?
- What are the ionic compounds?
- What are the covalent compounds?



California Science Standards

8.3.b, 8.3.c, 8.7.c

What Are Ionic and Covalent Compounds?

Many things are made of combinations of elements called *compounds*. Sugar, salt, gasoline, and chalk are all compounds because they have atoms of more than one element. But how are they alike and how are they different?

Scientists *classify*, or group, chemical compounds by the kinds of chemical bonds they have. A **chemical bond** joins atoms together to form compounds. The compounds are grouped by their bonding as either *ionic* or *covalent*.

Bonding happens between valence electrons of different atoms. *Valence electrons* are electrons in the outermost energy level of an atom. The type of compound that forms depends on what happens to the valence electrons. ✓

What Makes a Compound Ionic?

An ionic bond is an attraction between ions that have opposite charges. Compounds that have ionic bonds are called **ionic compounds**.

Ionic compounds can be formed by the chemical reaction between a metal and a nonmetal. Metal atoms become positively charged ions when electrons move from the metal atoms to the nonmetal atoms. When the electrons move, the nonmetal atoms gain a negative charge. ✓



Na¹⁺



Cl¹⁻

A sodium atom has lost an electron to a chlorine atom. The result is a positively charged sodium ion and a negatively charged chlorine ion. The attraction of the ions is called an ionic bond.

STUDY TIP

Work in Pairs Make flash cards with all of the vocabulary words in this section. Also make flash cards of the words in *italics* in this section.

On the other side of the card, write the definition of the word. Practice saying the words and their definitions.

READING CHECK

1. Identify What determines the type of compound that forms when atoms bond?

READING CHECK

2. Describe What kind of ions do metals form? What kind of ions do nonmetals form?

SECTION 1 Ionic and Covalent Compounds *continued*

What Are the Properties of an Ionic Compound?

Strong bonds are formed in ionic compounds because of the attraction between oppositely charged ions. These bonds make ionic compounds different from other compounds. There are several properties that tell you a compound is ionic.

IONIC COMPOUNDS ARE BRITTLE

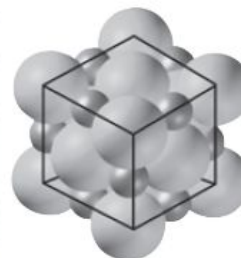
Ionic compounds tend to be brittle at room temperature. That means they break apart when hit. They break because their ions are arranged in a pattern that happens over and over again. The pattern is called a *crystal lattice*. Each ion in a lattice bonds to the ions around it that have the opposite charge. ✓

When you hit an ionic compound, the ions move and the pattern changes. Ions that have the same charge line up and repel each other. That makes the crystals break.

Sodium chloride crystals (shown below) all have a regular cubic shape because of the way sodium and chloride ions are arranged in the crystal lattice.

READING CHECK

3. Describe What is a crystal lattice?



Sodium chloride crystals all have a regular cubic shape because of the way sodium and chloride ions are arranged.

READING CHECK

4. Explain What causes ionic compounds to have high melting points?

IONIC COMPOUNDS HAVE A HIGH MELTING POINT

Because of the strong bonds that hold ions together, ionic compounds don't melt easily. They have a high melting point. That is the reason that most ionic compounds are solids at room temperature. For example, sodium chloride must be heated to 801°C before it will melt. ✓

IONIC COMPOUNDS ARE SOLUBLE

Many ionic compounds are highly *soluble* in water. That means they dissolve easily in water. Water molecules attract each of the ions of an ionic compound and pull the ions away from each other.

IONIC COMPOUNDS CONDUCT ELECTRICITY

The solution that forms when an ionic compound dissolves in water can conduct an electric current. It conducts electricity because its ions are now free to move freely past each other. When ionic compounds are solids, their ions are not free to move. They will not conduct an electric current. ✓

In the pictures below, the pure water does not conduct an electric current. However, the solution of salt water conducts a current, so the bulb lights up.



Pure water does not conduct an electric current.



However, the solution of salt water does conduct an electric current, so the bulb lights up.

What Makes a Compound Covalent?

Many of the compounds in your body are covalent compounds. **Covalent compounds** form when atoms share electrons. The bond that forms when atoms share electrons is called a *covalent bond*. Atoms share electrons to fill their outermost energy level. This forms a group of atoms, each having a full valence shell.

The group of atoms that make up a covalent compound is called a *molecule*. A molecule is the smallest particle that you can divide a compound into and still have the same compound. For example, if you break water down further, it isn't water anymore. It is hydrogen and oxygen.

READING CHECK

5. Explain Why do ionic compounds dissolved in water conduct an electric current?

CALIFORNIA STANDARDS CHECK

8.3.b Students know that compounds are formed by combining two or more different elements and that compounds have properties that are different from their constituent elements.

Word Help: constituent necessary part of a whole

6. Think and Explain How is the electrical conductivity of sodium chloride different from the conductivity of sodium metal?

What Are the Properties of Covalent Compounds?

The properties of covalent compounds are very different from the properties of ionic compounds.

SOME COVALENT COMPOUNDS DO NOT DISSOLVE IN WATER

Before you use salad dressing, you must shake the bottle to mix the oil and the water in the dressing. The oil and water separate because the oil has covalent compounds that are not soluble in water.

Covalent compounds that are not soluble in water contain molecules that are not attracted by water molecules. So, the water molecules stay together and the oil molecules stay together. ✓

✓ READING CHECK

7. Explain Why don't some covalent compounds dissolve in water?

COVALENT COMPOUNDS HAVE LOW MELTING POINTS

The forces of attraction between molecules in solid covalent compounds are much weaker than those that hold ionic solids together. It takes less heat to separate the molecules of covalent compounds. So, these compounds have much lower melting and boiling points than ionic compounds do.

COVALENT COMPOUNDS DO NOT CONDUCT ELECTRICITY WELL

Most covalent compounds that dissolve in water form solutions that have uncharged molecules. For example, sugar is a covalent compound that dissolves in water. But, it does not form ions. So a solution of sugar and water does not conduct an electric current as shown in the figure below. ✓



A solution of sugar, a covalent compound, in water does not conduct an electric current. This is because no ions form.

However, some covalent compounds do form ions when they dissolve in water. Many acids, for example, form ions in water. Acidic solutions conduct electricity.

✓ READING CHECK

8. Explain A covalent compound is dissolved in water. The solution does not conduct an electric current. Why not?
