

# Matter and Substances

## KEY IDEAS

As you read this section, keep these questions in mind:

- What makes matter?
- Why do atoms form bonds?
- What are some important interactions between substances in living things?

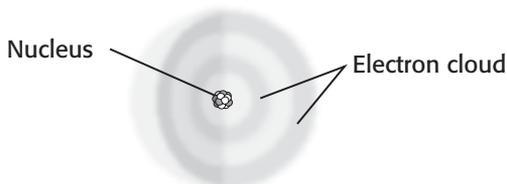
## What Does All Matter Have in Common?

Everything in the universe is made of matter. *Matter* is anything that has mass and takes up space. All matter is made up of atoms.

### ATOMS

An **atom** is the smallest unit of matter that cannot be broken down by chemical reactions. An atom has a core called a nucleus. The nucleus contains two types of particles: protons and neutrons. Protons and neutrons both have about the same mass. However, a *proton* has a positive charge. A *neutron* has no charge. ✓

An atom also contains *electrons*. An electron has a negative charge and moves around the nucleus in a region called the *electron cloud*. The mass of an electron is much smaller than the mass of a proton or a neutron.



The nucleus of an atom contains protons and neutrons. Electrons move around the nucleus in the electron cloud.

### ELEMENTS

An **element** is a substance that is made up of atoms that all have the same number of protons. For example, all atoms of the element carbon contain six protons. Also, all atoms that contain six protons are atoms of the element carbon. An atom is the smallest unit that has all the chemical properties of an element.

Atoms of the same element can have different numbers of neutrons. Atoms of the same element with different numbers of neutrons are called *isotopes*.

## READING TOOLBOX

**Discuss** Read this section quietly to yourself. As you read, write down questions that you have about the material. Then, go over the material with a partner or a small group. Together, try to figure out any parts you didn't understand.

## READING CHECK

**1. Compare** Give one similarity and one difference between protons and neutrons.

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## Critical Thinking

**2. Apply Concepts** An atom has five protons and six neutrons. Is the atom an atom of carbon? Explain your answer.

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**SECTION 1** Matter and Substances *continued*

## What Are Chemical Bonds?

Electrons occupy only specific levels within the electron cloud. Up to two electrons can occupy the first level. Other levels can hold more electrons. Electrons in the outermost level are called **valence electrons**. ✓

**READING CHECK**

**3. Define** What is a valence electron?

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**READING CHECK**

**4. Define** What is a molecule?

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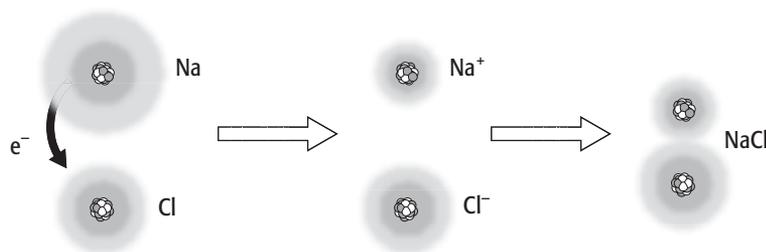
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Atoms are most stable when their outermost electron levels are filled. Therefore, most atoms combine, or *bond*, with each other so that each atom has a full outermost electron level. A **compound** forms when a chemical bond joins atoms of two or more different elements.

One way that atoms can form a chemical bond is by sharing electrons. This is called a *covalent bond*. Atoms held together by covalent bonds form a **molecule**. ✓

Atoms generally do not share the electrons in a covalent bond equally. As a result, one end, or *pole*, of a molecule has a slight negative charge. The other pole of the molecule has a slight positive charge. The result is a *polar molecule*. Water is an example of a polar molecule.

Another way that atoms can form chemical bonds is by losing or gaining electrons. When atoms gain or lose electrons, they form charged particles called **ions**.



- 1 A sodium atom loses an electron. The electron moves to a chlorine atom.
- 2 The sodium ion has a positive charge. The chloride ion has a negative charge.
- 3 The positive sodium ion and the negative chloride ion attract each other. This forms an *ionic bond*.

## LOOKING CLOSER

**5. Explain** Why does the sodium ion have a positive charge?

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## What Are Hydrogen Bonds?

When a hydrogen atom is bonded to an oxygen, nitrogen, or fluorine atom, the hydrogen atom has a relatively strong positive charge. It can attract the negative pole of other nearby molecules. This attraction is called a *hydrogen bond*, even though it is not a true chemical bond.

Hydrogen bonds are very important in many compounds in living things. For example, they help form the structures of DNA and of proteins.

# Section 1 Review

## SECTION VOCABULARY

**atom** the smallest unit of an element that maintains the chemical properties of that element

**compound** a substance made up of atoms of two or more different elements joined by chemical bonds

**element** a substance that cannot be separated or broken down into simpler substances by chemical means; all atoms of an element have the same atomic number

**ion** an atom, radical, or molecule that has gained or lost one or more electrons and has a negative or positive charge

**molecule** a group of atoms that are held together by chemical forces; a molecule is the smallest unit of matter that can exist by itself and retain all of a substance's chemical properties

**valence electron** an electron that is found in the outermost shell of an atom and that determines the atom's chemical properties

**1. Describe Relationships** How are atoms and elements related?

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**2. Compare** Fill in the blank spaces in the table below.

Type of particle	Location within an atom	Charge
	outside the nucleus	
Proton		
	in the nucleus	0

**3. Explain** Why do atoms form chemical bonds?

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**4. Compare** How is a covalent bond different from an ionic bond?

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**5. Define** What is a hydrogen bond?

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**6. Explain** Give one reason that hydrogen bonds are important in living things.

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