

Chapter 3 Chemical Foundations: Elements, Atoms, and Ions

3.1 The Elements

Key Term

element symbols

Summary

About 115 different elements are known. Of these, 88 are natural, and the rest have been created in laboratories. Of all the elements, nine are by far the most abundant. These nine – oxygen, silicon, aluminum, iron, calcium, sodium, potassium, magnesium, and hydrogen—make up 98 percent of all substances on Earth.

To make writing names of the elements simple, chemists use abbreviations, or *element symbols*. Many of these symbols consist of the first letter or the first two letters of the element name.

3.2 Atoms and Compounds

Key Terms

law of constant composition
compound

Dalton's atomic theory
chemical formula

atoms

Summary

In the early 1800s, English scientist John Dalton came up with an explanation of how *atoms* combine to form *compounds*. *Dalton's atomic theory* has five main points: (1) Elements are made up of atoms. (2) Each atom of an element is exactly the same as all the others. (3) The atoms of a particular element are different from those of any other element. (4) Atoms of elements can combine with atoms of other elements to form compounds, and any single compound always contains the same elements in the same amount in relation to one another. This principle is called the *law of constant composition*. (5) A chemical reaction changes only the way the atoms are grouped and never creates or destroys atoms.

Many compounds contain molecules. Molecules are described by a *chemical formula*, or set of element symbols and numbers. The types of atoms are indicated by element symbols. A number called a subscript tells how many atoms of each element the molecule contains.

3.3 Atomic Structure

Key Terms

electrons	nuclear atom	nucleus
protons	neutrons	isotopes
atomic number	mass number	

Summary

All types of atoms are made up of smaller particles. *Electrons* are negatively charged particles, *protons* are positively charged particles, and *neutrons* have no charge. Protons and neutrons are grouped together in a dense mass in the center of the atom, called the *nucleus*. Electrons move around the nucleus. The number of protons in an atom is equal to the number of electrons. As a result, the atom's positive and negative charges are balanced, and its charge is zero, or neutral.

An atom's electrons move around the nucleus at an average distance of about 63,000 times the diameter of the nucleus. Thus most of an atom is really empty space. The number and arrangement of its electrons give each element unique chemical properties. When atoms of different elements combine to form molecules, the atoms' electrons interact.

Chemists describe an element by assigning it an atomic number and a mass number. The *atomic number* is the number of protons. The *mass number* is the sum of protons and neutrons. The number of neutrons in atoms of the same element may differ. Atoms with the same number of protons but a different number of neutrons are called *isotopes*.

3.4 Using the Periodic Table

Key Terms

periodic table	groups	alkali metals
alkaline earth metals	halogens	noble gases
transition metals	metals	nonmetals
metalloids (semimetals)	diatomic molecules	

Summary

Chemists have organized all the known elements into a chart called the *periodic table*. The periodic table is made up of rows of boxes. Each box contains the symbol for an element below the element's atomic number. The elements are listed in order of increasing atomic number. They are also listed in horizontal rows and vertical columns. Elements with similar chemical properties that lie in the same column in the periodic table are called *groups*.

Most elements react easily with other elements. Few elements are found in nature in their pure state. Instead, they exist in combination with other elements in the form of compounds. Elements exist in different forms in their natural state at normal temperatures. Most elements

are solids. Several are gaseous. Only two elements are liquid at 25°C. Some elements form *diatomic molecules*—two atoms combined into a molecule.

3.5 Ions and Their Compounds

Key Terms

ion

cation

anion

ionic compounds

Summary

A charged particle, called an *ion*, can be produced by adding or removing one or more electrons from an atom. Removing an electron produces a positively charged ion, called a *cation*. Adding an electron produces a negatively charged ion, called an *anion*.

Many substances contain ions. Whenever a nonmetal and a metal combine to form a compound, it is likely to contain ions. Such a compound is called an *ionic compound*. The cations and anions in a compound must balance out to result in a charge of zero.

Additional Active Reading Questions

1. What are the nine most common elements on earth?
2. Write the symbols for the following elements: helium, argon, potassium, gold, boron, copper.
3. State the law of constant composition.
4. Write the chemical formula for a compound with one carbon atom and two oxygen atoms.
5. Which two types of particles make up the nucleus of an atom?
6. What is the source of an element's chemical properties?
7. How do you find the number of neutrons in an isotope?
8. What is the name for elements with similar chemical properties that lie in the same column in the periodic table?
9. Why are few elements found in nature in their pure form?
10. What is the name for a positively charged ion? a negatively charged ion?
11. What is an ionic compound?