

Chapter 3 Structure of Matter

Compounds

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.

Combining Elements

All matter is made of elements. In nature, most elements are found combined with other elements. A **compound** is a substance made of two or more elements chemically combined in a set ratio. For example, water is a compound made up of the elements hydrogen and oxygen.

When atoms combine, they form a **chemical bond**, which is a force of attraction between two atoms. There are two main types of chemical bonds: ionic bonds and covalent bonds. A group of atoms joined by covalent bonds is called a molecule.

Compounds can be represented by chemical formulas. A **chemical formula** is a combination of symbols that shows the elements in a compound and the ratio of the atoms. The chemical formula for water is H_2O . This formula tells you that the ratio of hydrogen atoms (H) to oxygen atoms (O) in the compound is 2:1. In a water molecule, two hydrogen atoms are chemically bonded to one oxygen atom.

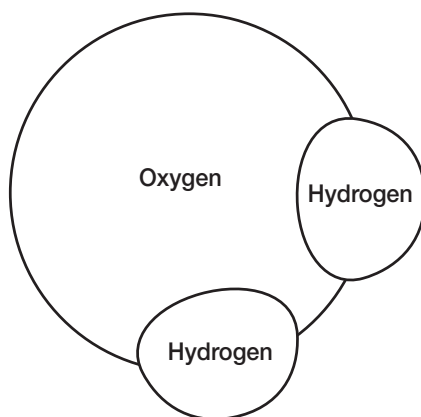


Figure 3–2 Water molecule In water (H_2O), the ratio of hydrogen atoms to oxygen atoms is 2:1.

Note that the physical and chemical properties of a compound differ from those of its component elements. For example, the component elements of water are hydrogen and oxygen. Both hydrogen and oxygen are gases at room temperature. In addition, both hydrogen and oxygen are flammable. The compound water is formed by the reaction of hydrogen and oxygen. Water is a liquid at room temperature. Water is not flammable. In fact, water can be used to put out many kinds of fires.

Chapter 3 Structure of Matter

Ionic and Covalent Bonds

Electrons in atoms have different amounts of energy. **Valence electrons** are the electrons that have the highest energy level and are held most loosely. Atoms with one, two, or three valence electrons can lose electrons and become more stable. When an atom loses an electron, it loses a negative charge and becomes a positive ion. An **ion** is an atom or group of atoms that has an electric charge. The symbol or formula for a positive ion contains a superscripted plus sign (+). For example, Na^+ represents a positive ion of sodium.

Atoms with five, six, or seven valence electrons usually become more stable when this number increases to eight. When an atom gains an electron, it gains a negative charge and becomes a negative ion. The symbol or formula for a negative ion contains a superscripted negative sign (-). For example, Cl^- represents a chlorine ion, the negative ion formed when a chlorine atom gains one electron.

An **ionic bond** is a chemical bond that forms as a result of the attraction between positive and negative ions. A compound that consists of positive and negative ions is called an **ionic compound**. An example of an ionic compound is sodium chloride (NaCl), or table salt.

Figure 3–3 illustrates the formation of an ionic bond by using electron dot diagrams. An **electron dot diagram** is a diagram of an atom that includes the symbol for the element surrounded by dots. Each dot represents one valence electron.

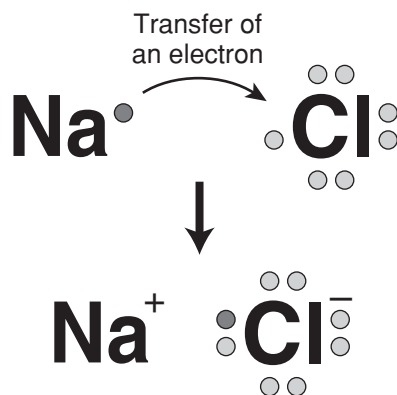


Figure 3–3 Ionic bond Ionic bonds form as a result of the attraction between positive and negative ions.

Chapter 3 Structure of Matter

The chemical bond formed when two atoms share electrons is called a **covalent bond**. Atoms are held together in a covalent bond by the attraction of each atom's nucleus for a shared pair of electrons. A **molecule** is a neutral group of two or more atoms joined by covalent bonds. A compound that is composed of molecules is called a **molecular compound**. Water (H_2O) is an example of a molecular compound. Figure 3–4 illustrates the formation of a water molecule from its component elements. A water molecule has two covalent bonds.

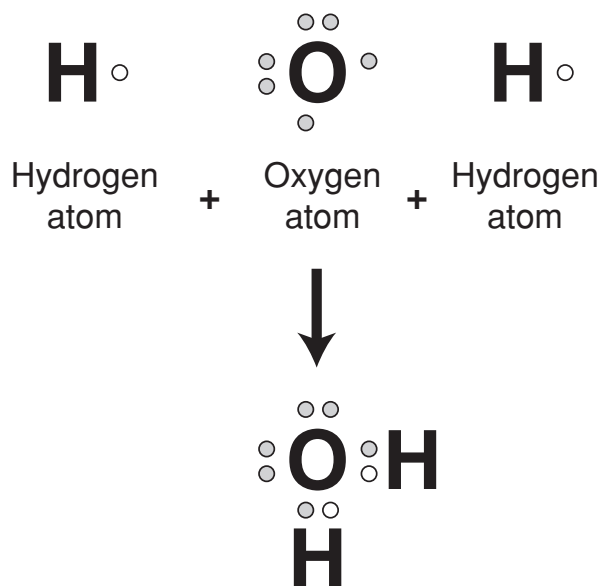


Figure 3–4 Covalent bonds In a water molecule, each hydrogen atom shares a pair of electrons with the oxygen atom. Each shared pair of electrons represents a covalent bond.

Standard 3. b. Check

5 A substance made of two or more elements chemically combined in a set ratio is a(an)

- A mixture.
- B ion.
- C compound.
- D solid.

6 An atom's valence electrons are those electrons

- A that have the highest energy level.
- B that are repelled by the nucleus.
- C that prevent atoms from bonding.
- D that are held most tightly.

Chapter 3 Structure of Matter**7 An ionic bond is**

- A** a group of two or more molecules held together.
- B** the chemical bond formed when two atoms share electrons.
- C** an atom or group of atoms that has an electric charge.
- D** the chemical bond formed by the attraction between positive and negative ions.

8 The atoms in a molecule of water are joined by

- A** ionic bonds.
- B** covalent bonds.
- C** unshared electrons.
- D** shared protons.

9

Which statement *best* describes the molecule shown in the diagram?

- A** Each hydrogen atom shares one pair of electrons with the nitrogen atom.
- B** Each hydrogen atom shares two pairs of electrons with the nitrogen atom.
- C** Three positive H^+ ions are attracted to the negative N^{3-} ion.
- D** Three negative H^- ions are attracted to the positive N^{3+} ion.