Glossary

atom: an element's smallest component or building block

atomic number: the number of protons in an atom

compound: are made up of different types of atoms held together by chemical bonds

electron: a negatively charged particle that resides outside of the nucleus in the electron orbital; lacks functional mass and has a charge of –1

element: one of 118 unique substances that cannot be broken down into smaller substances and retain the characteristic of that substance; each element has a specified number of protons and unique properties

isotope: one or more forms of an element that have different numbers of neutrons

mass number: the number of protons plus neutrons in an atom

matter: anything that has mass and occupies space

molecules: two or more neutral atoms chemically bonded together

neutron: a particle with no charge that resides in the nucleus of an atom; has a mass of 1

nucleus: (chemistry) the dense center of an atom made up of protons and (except in the case of a hydrogen atom) neutrons

orbital: an area where an electron is most likely to be found its

periodic table of elements: an organizational chart of elements, indicating the atomic number and mass number of each element; also provides key information about the properties of elements

proton: a positively charged particle that resides in the nucleus of an atom; has a mass of 1 and a charge of +1

radioactive isotope: an isotope that spontaneously emits particles or energy to form a more stable element

reactivity: the ability of elements to combine and chemically bond with each other

valence shell: the outermost electron shell

2.2 Chemical Bonds

Learning objectives

By the end of this section, you will be able to:

- *Understand how electrons can be donated, accepted, or shared between atoms to form chemical bonds*
- *Understand chemical bond strength; which bonds are stronger vs. which bonds are weaker*
- *Understand why chemical bonds differ in strength*
- *Describe the differences between polar covalent and nonpolar covalent bonds. Be able to give examples.*
- *Be able to define and explain all bolded terms*

Chemical Reactions and Molecules

According to the octet rule, all elements are most stable when their outermost shell is filled with electrons. This is because it is energetically favorable for atoms to be in that configuration, and it makes them stable. Since not all elements have enough electrons to fill their outermost shells, atoms form chemical bonds with other atoms. Forming chemical bonds allows atoms to obtain the electrons they need to achieve a stable electron configuration. When two or more atoms chemically bond with each other, a molecule is formed. The familiar water molecule, H_2O, consists of two hydrogen atoms and one oxygen atom. These atoms bond together by sharing electrons to form the water molecule, as Figure 2.12 illustrates. Atoms can form molecules by donating, accepting, or sharing electrons to fill their outer shells.

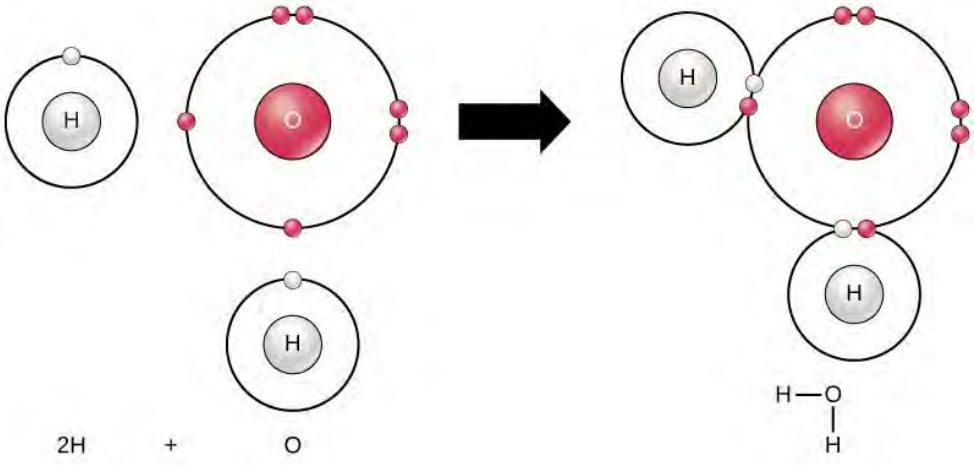

Figure 2.12 When two hydrogens and an oxygen share pairs of electrons via covalent bonds it forms a water molecule. (credit: Clark et al./Biology 2E OpenStax)

Chemical reactions occur when two or more atoms bond together to form molecules or when bonded molecules break apart. We usually call the substances used at the beginning of a chemical reaction **reactants**, and the substances at the end of the reaction **products**. We typically draw an arrow between the reactants and products to indicate the chemical reaction's direction. To create a water molecule, the chemical equation would be:

$$\mathbf{2H + O \rightarrow H_2O}$$

An example of a simple chemical reaction is breaking down hydrogen peroxide molecules. Each hydrogen peroxide molecule consists of two hydrogen atoms bonded to two oxygen atoms (H_2O_2). H_2O_2 is the chemical formula for hydrogen peroxide. A **chemical formula** is a way to show how many and which atoms make up a molecule.

The reactant hydrogen peroxide breaks down into water (H_2O), and an oxygen molecule (O_2). In the equation below, the reaction includes two hydrogen peroxide molecules and two water molecules. This is an example of a balanced chemical equation. Each element's number of atoms is the same on each side of the equation. According to the law of conservation of matter, the number of atoms before and after a chemical reaction should be equal. Under normal circumstances, atoms cannot be created or destroyed.

$$\mathbf{2H_2O_2\ (hydrogen\ peroxide) \rightarrow 2H_2O\ (water) + O_2\ (oxygen)}$$

All the reactants and products of this reaction are molecules. However, in this reaction, only hydrogen peroxide and water are chemical **compounds** meaning they contain atoms of more than one type of atom. Molecular oxygen, as Figure 2.13 shows, consists of two oxygen atoms double-bonded together and is not classified as a compound but as a molecule.

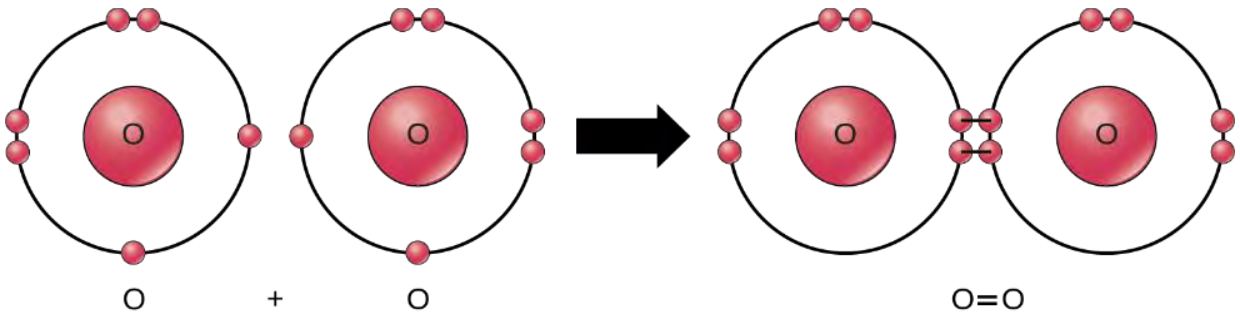

Figure 2.13 A double bond joins the oxygen atoms in an O_2 molecule. (credit: Clark et al./Biology 2E OpenStax)