




4.1: Hydrogen, Oxygen, and Water

Hydrogen (H_2) is an explosive gas used as a fuel in rocket engines. Oxygen (O_2), also a gas, is a natural component of the air on Earth. Oxygen is not itself flammable but must be present for combustion (burning) to occur. Hydrogen and oxygen both have extremely low boiling points, as you can see from the table. When hydrogen and oxygen combine to form the compound water (H_2O), however, a dramatically different substance results.

Selected Properties	Hydrogen 	Oxygen 	Water 
Boiling Point	$-253\text{ }^{\circ}\text{C}$	$-183\text{ }^{\circ}\text{C}$	$100\text{ }^{\circ}\text{C}$
State at Room Temperature	Gas	Gas	Liquid
Flammability	Explosive	Necessary for combustion	Used to extinguish flame

First of all, water is a liquid rather than a gas at room temperature, and its boiling point is many degrees higher than the boiling points of hydrogen and oxygen. Second, instead of being flammable (like hydrogen gas) or supporting combustion (like oxygen gas), water actually extinguishes flames. Water is nothing like the hydrogen and oxygen from which it forms. The dramatic difference between the elements hydrogen and oxygen and the compound water is typical of the differences between elements and the compounds that they form. *When two or more elements combine to form a compound, an entirely new substance results.*

Although some of the substances that we encounter in everyday life are elements, most are compounds. As we discussed in [Chapter 1](#), a compound is different from a mixture of elements. In a compound, elements combine in fixed, definite proportions; in a mixture, elements can mix in any proportion whatsoever. Consider the difference between a hydrogen–oxygen mixture and water as shown in [Figure 4.1](#). A hydrogen–oxygen mixture can have any proportion of hydrogen and oxygen gas. Water, by contrast, is composed of water molecules that always contain two hydrogen atoms to every one oxygen atom. Water has a definite proportion of hydrogen to oxygen.

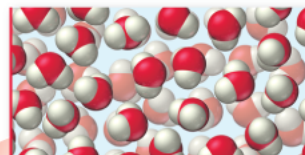
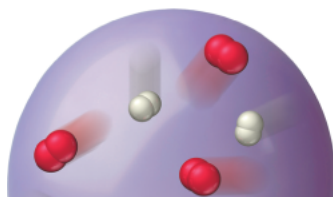
Figure 4.1 Mixtures and Compounds

The balloon in this illustration contains a mixture of hydrogen gas and oxygen gas. The glass contains water, a compound of hydrogen and oxygen.

Mixtures and Compounds

Hydrogen and Oxygen Mixture
This can have any ratio of hydrogen to oxygen.

Water (A Compound)
Water molecules have a fixed ratio of hydrogen (two atoms) to oxygen (one atom).





In this chapter we examine compounds. We discuss how to represent them, how to name them, and why they form. In the last part of the chapter, we learn how to quantify their elemental composition.

Not for Distribution