

5.1: Elements Combine to Form Compounds

When building a house, the starting point is a blueprint of what the house will look like. The plan states how many windows and what kind, how many doors and what style, how many rooms and what type (bedroom, kitchen, other). The blueprint shows how the different pieces will go together to make the house. As long as the blueprint is followed and exactly the same items are used, the house will be identical to its blueprint.

Compounds

A **compound** is a substance that contains two or more elements chemically combined in a fixed proportion. The elements carbon and hydrogen combine to form many different compounds. One of the simplest is called methane, in which there are always four times as many hydrogen atoms as carbon atoms. Methane is a pure substance because it always has the same composition. However, it is not an element because it can be broken down into simpler substances – carbon and hydrogen.

Recall that the components of a mixture may be separated from one another by physical means. This is not true for compounds. Compounds require chemical means to separate them into elements and/or simpler compounds.

Sodium chloride, also known as table salt, is an ionic compound with the chemical formula NaCl, representing a 1:1 ratio of sodium and chloride ions. It is commonly used as a condiment and food preservative. Salt can be created by adding two very reactive elements together: sodium, Na (s), metal and chlorine, Cl₂ (g), gas.



The element sodium ([Figure 5.1.1a](#)) is a very reactive metal. Given the opportunity, it will react with the sweat on your hands and form sodium hydroxide, which is a very corrosive substance. The element chlorine ([Figure 5.1.1b](#)) is a pale yellow, corrosive gas that should not be inhaled due to its poisonous nature. Bring these two hazardous substances together, however, and they react to make the ionic compound sodium chloride ([Figure 5.1.1c](#)), known simply as salt.

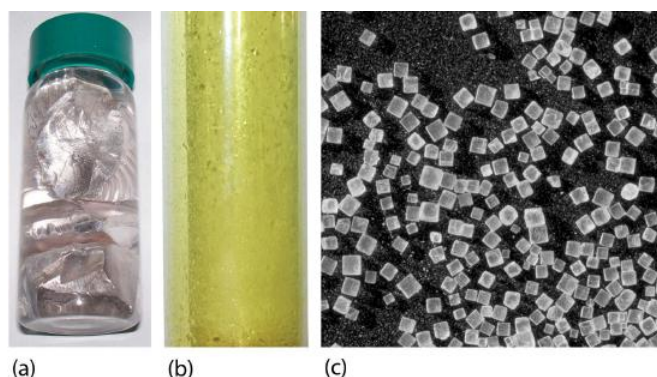


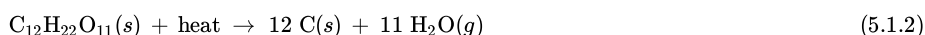
Figure 5.1.1: Sodium + Chlorine → Sodium Chloride (a) Sodium is a very reactive metal. (b) Chlorine is a pale yellow, noxious gas. (c) Together, sodium and chlorine make sodium chloride – salt – which is necessary for our survival. Source: (a) courtesy of [reenhorn1](#), (b) courtesy of [Benjah-bmm27](#), (c) © Thinkstock.

Salt is necessary for life. Na⁺ ions are one of the main ions in the human body and are necessary to regulate the fluid balance in the body. Cl⁻ ions are necessary for proper nerve function and respiration. Both of these ions are supplied by salt. The taste of salt is one of the fundamental tastes; salt is probably the most ancient flavoring known, and one of the few rocks we eat. Clearly when the elemental sodium and chlorine combine ([Equation 5.1.1](#)), the resulting salt product has radically different properties (both physical and chemical). This reaction is spectacular to observe ([Video 5.1.1](#)).



Video 5.1.1: Making table salt using sodium metal and chlorine gas

Another compound is sugar, which is the generic name for sweet, soluble carbohydrates, many of which are used in food. Sugar has the chemical formula $C_{12}H_{22}O_{11}$ and is constructed from different elements than salt: carbon, hydrogen and oxygen. While sugar qualitatively resembles table salt (often confused in the kitchen), the two have distinctly different physical and chemical properties. There are various types of sugar derived from different sources. While sugar is made with carbon, hydrogen, and oxygen, it is considerably harder to synthesize from its constituent elements than table salt ([Equation 5.1.1](#)). However, the thermal decomposition is considerably easier and can be represented as a dehydration of sucrose to pure carbon and water vapor in [Equation 5.1.2](#), and demonstrated in [Video 5.1.2](#).



Video 5.1.2: A science experiment in the kitchen shows what happens to sugar molecules when they are heated. The experiment did not disappoint!

As with salt, sugar has radically different properties (both physical and chemical) than its constituent elements. This difference in properties of constituent elements and compounds is a central feature of chemical reactions.

Summary

- A compound is a substance that contains two or more elements chemically combined in a fixed proportion.
- Compounds may be broken down into simpler substances by chemical means.

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