ELEMENTS AND COMPOUNDS

reflect

Suppose you had all of the parts needed to make an aquarium: a bowl, water, rocks, plants, and a fish. To put the aquarium together, you would need to arrange the rocks and plants in the bowl. Then you would likely add the water. Finally, you would need to place the fish in the bowl to give it a new home.

If you were missing one of these components, such as the water or the bowl, you would not have an aquarium. All of the parts of the aquarium are important to create a place for your fish. You need the bowl to hold the water. The fish needs the water for its environment and the plants and rocks for hiding.

Which parts of the aquarium are made up of smaller parts? Can you break down these smaller parts into even smaller parts? What does this have to do with matter?

Matter, mass, and volume are related.

All of the parts of the aquarium the bowl, water, plants, rocks, and fish are made of matter. *Matter* is anything that has mass and volume. *Mass* is a measure of the amount of matter a substance contains. For example, consider the parts of the aquarium. Compared to the fish, the bowl and water contain a lot more matter and have larger masses. The fish contains little matter and has a small mass. The bowl, water, plants, rocks, and fish also have *volume*, which is a measure of how much space each takes up. Matter can be made of just one substance, such as water. Matter can also be a combination of substances. For example, lemonade is a mixture of water, sugar, and lemons.

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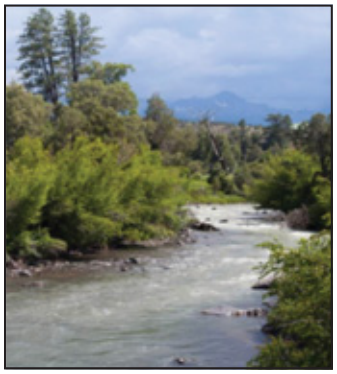
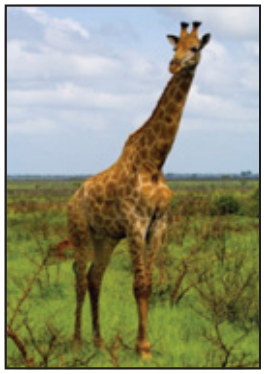
what do you think?

The picture on the left shows a river through the mountains. The picture in the middle shows a kitchen. The picture on the right shows a giraffe in the African plains. Identify the different examples of matter in each image. Which has the greatest mass? The greatest volume?





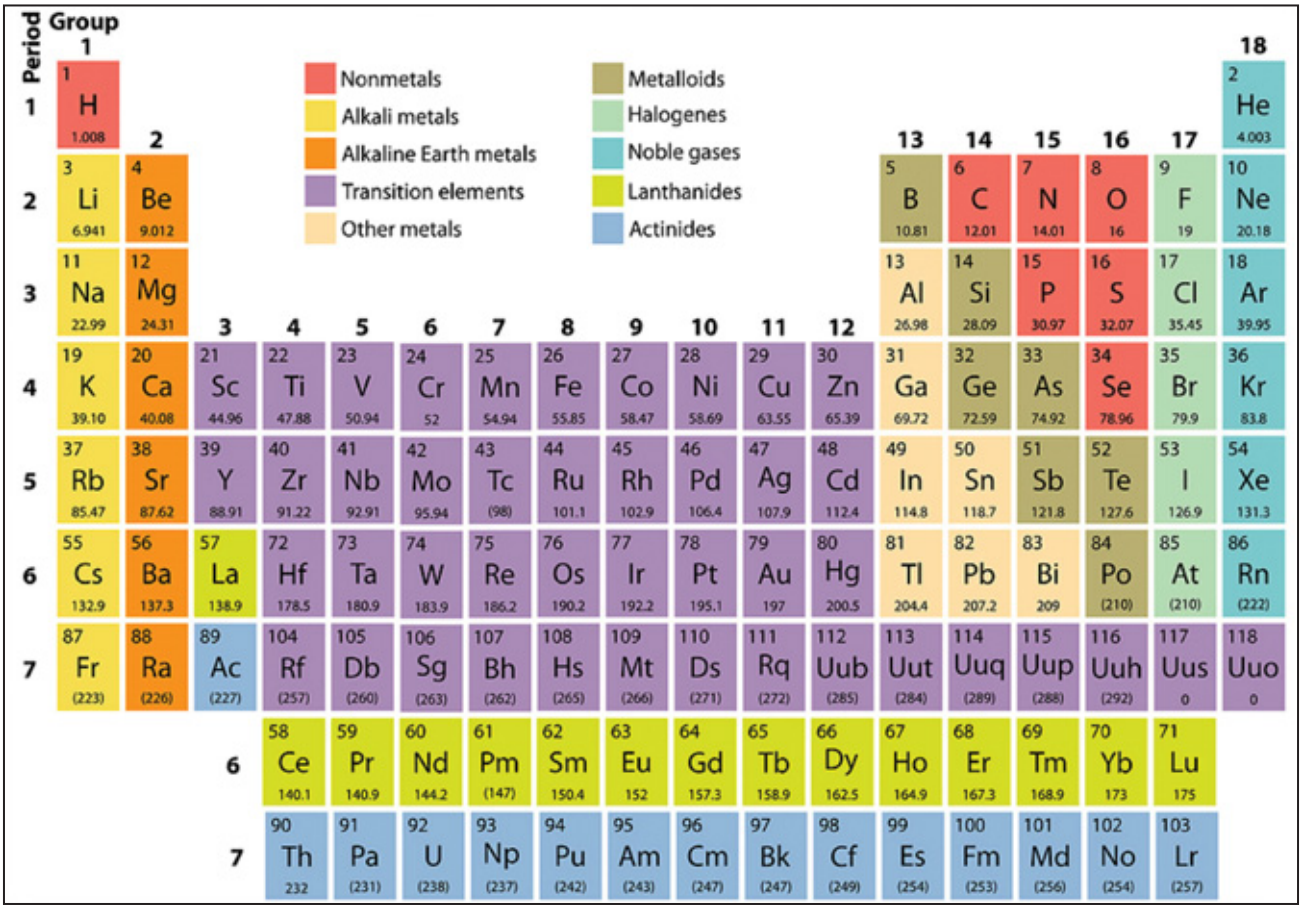
Elements and compounds are matter.
Water is one of the most common substances on Earth. It makes up the oceans, lakes, and streams. Water collects in the clouds and falls to the ground as rain and snow. You are even made of water—in fact, about 60% of the human body is water. But, what makes up water? When you look at a glass of water, you may see a clear, flowing liquid or small, colorless droplets. If you were to study the liquid under a powerful microscope, however, you would find that water is made of elements that are joined to each other. An *element* is a pure substance that cannot be broken down into different substances. In the case of water, the elements are hydrogen and oxygen.

Water, a compound, is made of the elements hydrogen and oxygen.

Because water is made of more than one element, it is called a *compound*. A compound is formed when two or more elements combine chemically. Typically, compounds have properties that are different than the elements they are made of. The properties of water are much different than the properties of hydrogen and oxygen. For example, at standard temperatures, hydrogen and oxygen are gases, while water is a liquid. Another common compound is salt. It is made of the elements sodium and chlorine.

look out!

Scientists arrange all of the elements into an organized chart known as the *periodic table of elements*. The table contains more than 100 elements, which are organized according to their properties. The periodic table may look slightly different in different sources. Not every source includes the exact same information as the example on the right. However, all the elements always appear in the same locations on the periodic table. It is always organized the same way.



Scientists use symbols as a quick way to represent each element. These symbols are one- or two-letter codes. Recall that hydrogen and oxygen make up water, and sodium and chlorine make up salt. Hydrogen has the chemical symbol “H.” It is found at the top of Group 1 of the periodic table. Oxygen has the chemical symbol “O.” It is found at the top of Group 16. Sodium has the chemical symbol “Na.” It is also found in Group 1. Chlorine has the chemical symbol “Cl.” It is found in Group 17. Because both hydrogen and sodium are found in the same group, they have similar properties.

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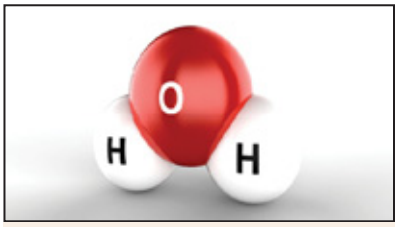
Atoms and molecules are matter.
Imagine that you had an extremely powerful microscope that allowed you to see an individual particle of oxygen. This oxygen particle is an atom. An *atom* is the smallest part of an element that still has the properties of the element. Hydrogen, sodium, chlorine, and all other elements are made up of atoms.

In a similar way, suppose that you used the microscope to see an individual water molecule. A *molecule* is formed when two or more atoms join together chemically. In water, two hydrogen atoms and one oxygen atom combine to form a water molecule. A molecule of salt is formed when one sodium atom and one chlorine atom form a bond.



A water molecule is made of two atoms of hydrogen bound to one atom of oxygen.

A mixture is different than a pure substance.
Matter is a *pure substance* when it is made of only one kind of atom or molecule. Elements are pure substances because each element is made up of a single kind of atom. Minerals such as graphite and diamond are also pure substances. They are made of only one element: carbon. A *compound* made of only one kind of molecule is also a pure substance. Water, which is a compound of hydrogen and oxygen, is a pure substance. There are only water molecules in water.

Unlike a pure substance, a *mixture* is made up of many different kinds of atoms and molecules. Mixtures form when two or more substances combine physically but not chemically. As a result, the different parts of a mixture keep their properties. When you mix rocks and water in a fishbowl, each substance keeps its own properties. You can also separate the different parts relatively easily. The rocks fall to the bottom of the water.

look out!

Sometimes mixtures are not easy to identify. When you dissolve salt in a glass of water, you form a mixture. You cannot see the salt in the water but if you evaporate the water, the salt will be left in the glass. Air is also a mixture. Sometimes people think that air is made up of only one gas, such as oxygen. However, air is actually a mixture of different gases. By volume, the most abundant gases in the air are nitrogen, oxygen, and argon. Oxygen, which your body uses when you breathe, is the second most plentiful gas in the air.

Gas	Chemical Notation	Percent %
Nitrogen	N_2	78.1
Oxygen	O_2	20.9
Argon	Ar	0.93
Carbon dioxide	CO_2	0.035
Other gases		0.035

This table shows the main gases that make up air. Most air also contains water vapor.

Different elements are found in the lithosphere, biosphere, hydrosphere, and atmosphere.

Scientists divide Earth into many different sections, or spheres. Each sphere contains only a small number of different elements. However, these elements are found in different amounts in different spheres. Let's take a closer look at the elements that are found in four of the most important spheres.

- **Lithosphere:** The lithosphere is the solid part of Earth. It contains rocks and minerals. Oxygen and silicon are the most abundant elements in this sphere. There are also small amounts of metals such as aluminum, iron, calcium, and sodium.
- **Biosphere:** The biosphere contains Earth's living matter. All plants and animals are part of this sphere. Oxygen, carbon, hydrogen, nitrogen, calcium, and phosphorus are the most abundant elements in living things.
- **Hydrosphere:** All of the water on Earth is part of the hydrosphere. The main component of the hydrosphere, the oceans, makes up more than 70% of Earth's surface. Because water is made of oxygen and hydrogen atoms, these two elements are the most common in the hydrosphere.
- **Atmosphere:** The atmosphere includes the air that surrounds Earth. Remember that air is a mixture of different gases. The most abundant of these gases are nitrogen, oxygen, and argon.

Everyday Life: Pollution changes the abundance of elements in Earth's spheres.

Pollution is the contamination of the environment by different substances. Most pollution is caused by industry, agriculture, and everyday human activity. Although hydrogen and oxygen are most abundant in the hydrosphere, water pollution adds additional elements to aquatic life. For example, when we fertilize crops, we risk adding nitrogen and phosphorus to water sources through agriculture runoff. These elements increase the amount of algae that grow in the water, and the extra algae use up resources like dissolved oxygen. This means there are fewer resources for other organisms, causing the aquatic life to suffer.

Industrial waste often in the form of water, air, and soil pollution causes a significant amount of harm to our environment.

When air becomes polluted, the amount of each gas in the air changes. For example, some types of air pollution, such as automobile exhaust, increase carbon dioxide and ozone levels. Many scientists think that increasing carbon dioxide causes *global warming*, the gradual

increase of Earth's temperature. This is because carbon dioxide in the atmosphere traps heat at Earth's surface. Ozone can cause a number of respiratory health issues, such as asthma. Ozone can also harm different plants and animals in the environment. Since most of these gases are invisible, you may not even be aware that these changes are occurring.

What do you know?

You can find matter in different forms: a pure substance or a mixture. Study the list of terms in the box below. Decide if each term is a pure substance or a mixture. If the substance is a pure substance, determine if it is a compound or an element. Write your answers in the table below the list.

Substance	
• water	• air
• salt	• argon gas
• sea water	• carbon dioxide
• lemonade	• tin can
• graphite	• cake batter
• gold bracelet	

Pure Substance		Mixture
Element	Compound	

connecting with your child

Sources of Pollution

Most of the pollution that harms the environment results from human activities. Work with your child to identify specific elements and compounds that are responsible for different types of pollution. To do this, research the prevalence of different types of pollutants on Earth or, preferably, affecting a local area such as a river or a field. You may conduct your research using magazines, newspapers, or online sources. Here are some suggestions to get you started:

- **Air pollution:** A major cause of air pollution is the burning of fossil fuels. Humans burn fossil fuels such as gasoline and diesel fuel when driving automobiles; they also burn fossil fuels such as coal, oil, and natural gas when heating their homes and generating electricity. Products of these reactions are ozone, carbon dioxide, sulfur dioxide, and carbon monoxide.
- **Water pollution:** Any activities that use water are possible causes of water pollution. Sewage and detergents can find their way into nearby water bodies, and the overuse of water to cook, clean, and bathe can strain the local water supply. Plastics, detergents, and oil are potential compounds that are common in water pollution.
- **Soil pollution:** One of the causes of soil pollution results from improperly disposing of waste materials. Solvents, petroleum, lead, and other heavy metals cause significant contamination of the soil.

When you and your child have identified different substances in pollution, work together to identify which substances are compounds or elements. Here are some questions to ask your child:

- How can you prevent or limit some of these sources of pollution?
- Is a particular pollutant introduced to the environment in the form of a mixture or a pure substance?
- How can you clean up pollution caused by a particular elements or compounds?