MIXTURES AND SOLUTIONS

The next time you are enjoying yourself at a beach, pick up a handful of sand and look closely at it. You might see many different tiny rocks or pieces of seashells. Some might be red, yellow, black, white, pink, gray, or other colors. The handful of sand is a *mixture* of several different things.

Mixtures are everywhere, but most people don't notice them. The sidewalk you walk on is a mixture. Look at it with a hand lens. You might be surprised at what you see. Look in your desk. The contents may be a mixture of school papers, pencils, dust, paper clips, or other things. The bag of mixed nuts that you eat as a snack is a mixture. A cup of vegetable soup is a mixture of peas, carrots, potatoes, and perhaps beans or celery. Any time two or more different objects or materials are put together or combined, they form a mixture.

You can make mixtures yourself. You can make your own mixture of nuts if you have several different kinds, such as pecans, cashews, and sunflower seeds. Or you can chop up several kinds of lettuce, some tomatoes, and maybe a cucumber to make a mixed salad. What do you think salad dressing is? That's right, it's a mixture. A salad dressing might be a mixture of vinegar, olive oil, salt, pepper, and herbs such as rosemary and oregano. And if you ate some nut mix, followed by some vegetable soup and salad with dressing, just think about the mixture in your stomach!

Some mixtures are made by combining solids and liquids. You might have started your day with a mixture of cereal, milk, and sugar. Or maybe you ate pancakes made with flour and milk. Did you ever mix cocoa powder (a solid) with milk (a liquid) to make chocolate milk? That's another tasty mixture.

What Is It?

Can you guess what these photographs are? Are they mixtures or solutions?

Sand

Granola

Tea

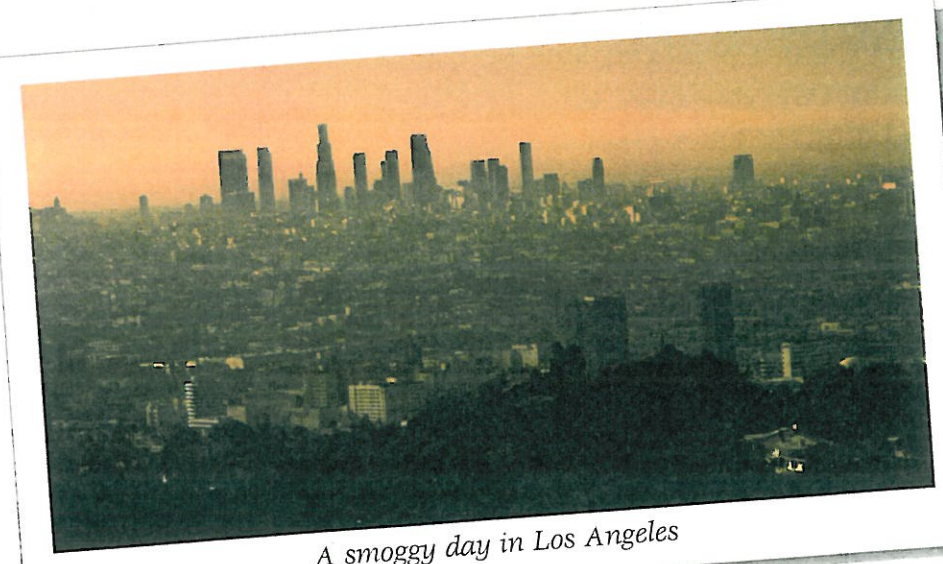
Sometimes when you mix a solid and a liquid, an interesting thing happens. The solid material seems to disappear. If you ever put sugar in iced tea or lemonade powder in a glass of water, you probably noticed this happen. The sugar or powder went to the bottom of the glass, but after a bit of stirring, you could not see it. When a solid material seems to disappear in a liquid, the mixture is called a *solution*. Solutions are always clear. You can see through solutions. A solution can be colored, like iced tea or lemonade, but it must be clear. Do you think chocolate milk is a solution?

When a solid disappears in a liquid, we say the solid has *dissolved* in the liquid. The scientific names for the solid and liquid are *solute* and *solvent*. If you mix salt and water, the salt is the solute. It dissolves in the solvent, which is the water.

Substances in solutions are so tiny that you can't see them. You can't see a spoonful of sugar or salt in water, but you know it is there because you can taste it. Substances can be made smaller and smaller until they are invisible to your eyes.

A solution isn't always made with a solid and a liquid. Solutions can be made with two liquids. Corn syrup can dissolve in water. Liquid detergent can also dissolve in water. Which liquid do you think is the solvent, and which is the solute? Solutions can also be made with liquids and gases. Carbon dioxide is dissolved in water to put the fizz in soda drinks.

The air you breathe is a solution. It is a mix of different gases dissolved in nitrogen. When gases from vehicles and particles of dust and dirt are added to the air in large quantities, we call the air *smog*. Some people have difficulty breathing very smoggy air.



A smoggy day in Los Angeles

Mixtures can be taken apart. You can clean up your drawer and put things in their proper places. You can separate your handful of sand into the different kinds of materials in the mixture. You can separate the kinds of nuts in your snack to eat each type one at a time.

Mixtures that are solutions can also be taken apart. Ocean water is a solution of salt and water (and often other minerals). To separate salt from a saltwater solution, all you have to do is let the water *evaporate*. When it does, the salt will be left. Most solutions can be separated by evaporation.

All solid objects on Earth can be broken down or worn down into smaller and smaller pieces. Mountains are mixtures of rocks and minerals. River bottoms are mixtures of smaller rocks and minerals that have been worn away from mountains and other places. River sand is a mixture of even smaller rocks and minerals. River silt is a mixture of very tiny rocks and minerals.

Today we know that some substances on Earth are not mixtures. They are called *elements*. Gold is an element. No matter how you break up gold, all the pieces are still gold, even down to the tiniest pieces. Copper is another element. So are oxygen and helium. Ninety-two different elements are found naturally on Earth. Everything on Earth is made out of one or more of these elements.

The First 30 Elements

The following list shows the first 30 elements, ordered from the lightest to the heaviest atoms. Look at the list to answer the following questions.

- What is the lightest atom on the list? The heaviest on the list?
- Is aluminum heavier or lighter than titanium?
- Is iron heavier or lighter than titanium? Than aluminum?
- The air we breathe is mostly a mixture of oxygen and nitrogen. The amount of nitrogen in the air is four times greater than the amount of oxygen. Which of these two elements is the lighter?
- Argon, neon, oxygen, fluorine, nitrogen, chlorine, and helium are all gaseous elements. Put these seven gases in order from lightest to heaviest.
- Iron, aluminum, nickel, titanium, chromium, copper, zinc, and cobalt are all metal elements. Put these eight metals in order from lightest to heaviest.

1 Hydrogen	**11** Sodium	**21** Scandium
2 Helium	**12** Magnesium	**22** Titanium
3 Lithium	**13** Aluminum	**23** Vanadium
4 Beryllium	**14** Silicon	**24** Chromium
5 Boron	**15** Phosphorus	**25** Manganese
6 Carbon	**16** Sulfur	**26** Iron
7 Nitrogen	**17** Chlorine	**27** Cobalt
8 Oxygen	**18** Argon	**28** Nickel
9 Fluorine	**19** Potassium	**29** Copper
10 Neon	**20** Calcium	**30** Zinc

For many centuries, people wondered how small the smallest piece of something could be. Scientists have given a name to the tiniest piece of an element. The tiniest piece is called an *atom*. Gold is made up of gold atoms, and copper is made up of copper atoms. Oxygen atoms make up the oxygen in the air we breathe. We use helium atoms to fill balloons. Atoms are so small that you can't see them. It takes about 1 million copper atoms to make a tiny, visible piece of copper. It would take 39 million copper atoms side by side to make a line 1 centimeter (one-half inch) long.

Scientists have put the 92 natural elements in order from the lightest to the heaviest. The first element is hydrogen. It is the lightest and the most common element in the universe. The Sun is made up mostly of hydrogen. On Earth, hydrogen is a gas. It is used as rocket fuel.

Element 2 is helium. It is the next lightest atom. Helium is also a gas. Because it is lighter than air, it is used to fill blimps and party balloons.

The Amazing Atom

The idea of the atom was conceived by Greek philosophers more than 2,000 years ago. They thought that if something was cut into smaller and smaller pieces, eventually it would be divided into pieces too small to cut. They called these pieces *atoms*. Atom comes from the Greek word *atomos*, which means "that which cannot be cut."

Atoms are so small that you can't see them directly. Just how small are they?

- One drop of water contains more than 100,000,000,000,000,000,000 (100 billion billion) atoms.
- It would take all the people in the world all their lifetimes to count the number of atoms in one letter on this page.

What element was used to fill this blimp?

SUPER SCIENTISTS

Henry Cavendish

(1731–1810)

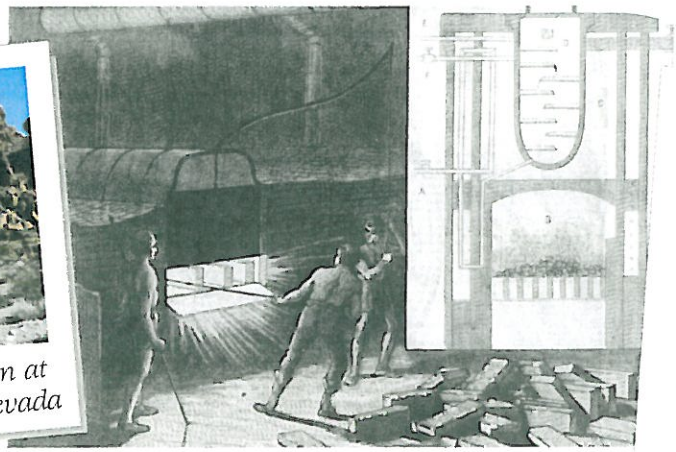
English chemist Henry Cavendish is most famous for his study of the composition of air. He showed that air is a mixture of more than one gas. He was the first person to isolate hydrogen from air. He called it "inflammable air" because it seemed to burn easily. Cavendish was also the first to find that water is made up of two elements, hydrogen and oxygen.

Henry Cavendish

Element 8 is very important. It is oxygen. It is part of the solution we call air. Humans and other animals take in oxygen when they breathe. You need oxygen to stay alive. Nearly all organisms need it to survive.

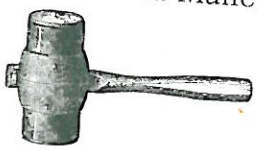
Element 26 is iron. When you see red-colored hillsides or mountains, it is likely that they contain iron. People found that they could remove iron from the mixture of red dirt using heat. They could melt the iron and form it into different shapes. For many centuries, iron has been a very useful element for making tools.

A landscape made red by iron at Valley of Fire State Park in Nevada



The manufacture of iron by the petroleum process, from 1880

Iron-Bound Mallets



Iron-ring mallet

Round iron mallet

Interesting stories can be told about each of the 92 elements. Each has been useful in some way to humans. *Chemists* study the elements. They study how elements can be combined and how elements and their combinations can be used. Chemists will have plenty to do for a long time, because there are many things still to be learned about elements.

QUESTIONS TO EXPLORE

- What are some examples of mixtures?
- How can mixtures be separated?
- What is an element?

Atom Symbols

People use abbreviations or symbols to stand for things or ideas. The names of states are represented by abbreviations. New York, for example, can be represented by the abbreviation NY. TX is the abbreviation for Texas. CA is the abbreviation for California. What is the abbreviation for the state in which you live?

Atoms are represented by symbols. O is the symbol for oxygen. N is the symbol for nitrogen. I is the symbol for iodine.

Some names of atoms begin with the same letters, so the same symbol cannot be used for both. This is why the hydrogen symbol is H, and the helium symbol is He. C is carbon, while Ca is calcium.

In early times, Romans and Greeks used substances such as gold, silver, and iron to make art objects and tools. They used words in their own languages to name the substances. The Latin word for gold is *aurum.* Silver was called *argentum.* Iron was called *ferrum.* Today the atoms for these elements are given the symbols Au, Ag, and Fe.

Take some time to look at the periodic table that lists the 92 natural elements (see page 36). See if you can find other symbols that come from Roman or Greek words.

Athena, the Greek goddess of wisdom, wearing a crown of gold