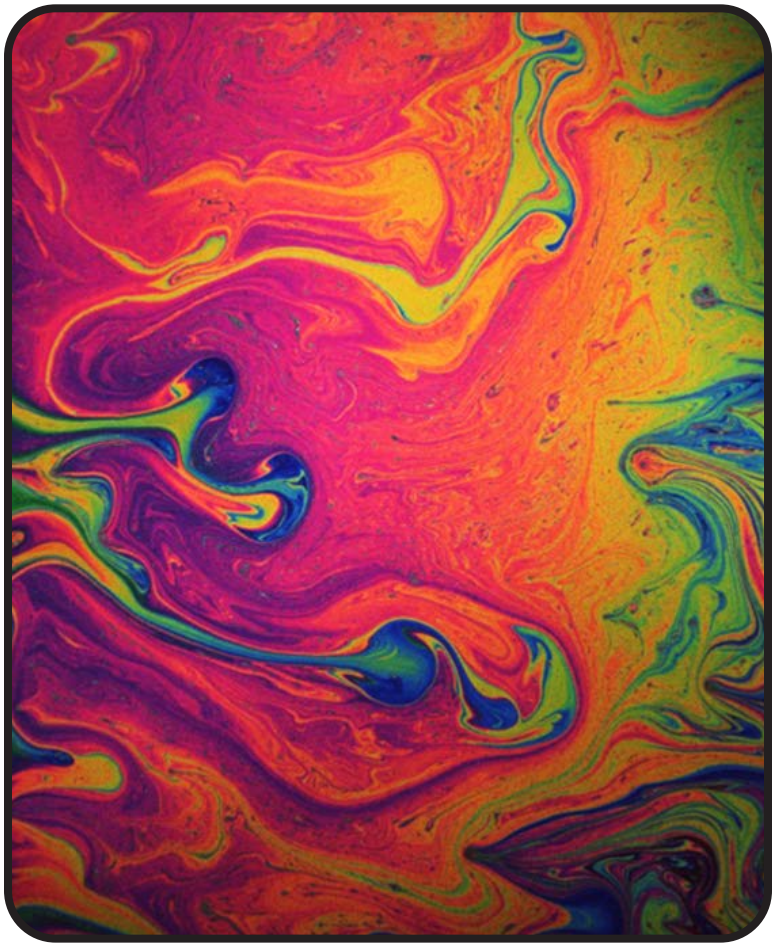
Mixing Matter

A Science A–Z Physical Series

Word Count: 1,504



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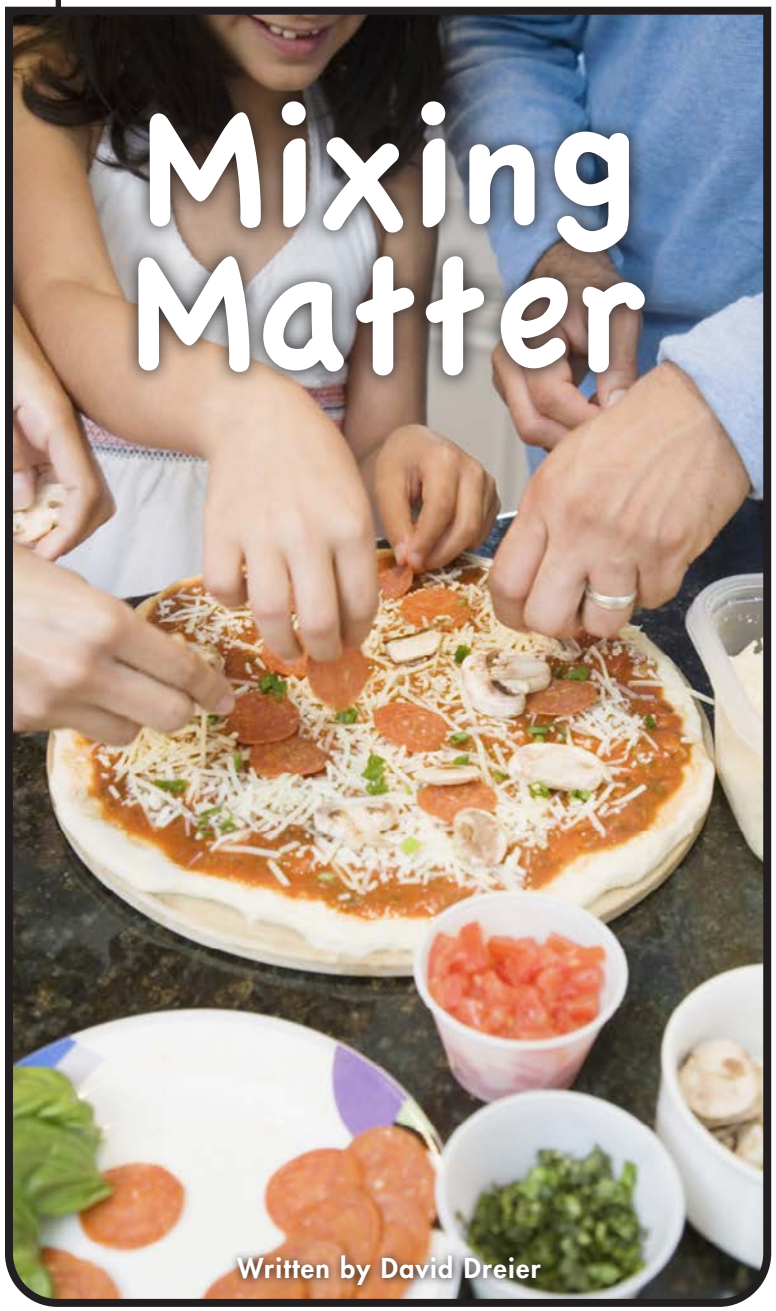

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protons tiny particles that are part of the nucleus of an atom; they have a positive electrical charge (p. 7)

saturated being at the point at which no more of a liquid, solid, or gas can be absorbed by a solution at a given temperature (p. 16)

solution a mixture in which the atoms of a solid separate and become invisible in a liquid (p. 15)

suspension a mixture of a liquid and a solid in which the solid does not dissolve (p. 19)

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Written by David Dreier

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KEY ELEMENTS USED IN THIS BOOK

The Big Idea: Everything is made of tiny particles called atoms. These atoms combine to form molecules. Atoms and molecules can combine with other atoms and molecules in many ways to form many different types of things. It is important to understand how materials change when combined. Some materials retain their own properties, while other materials form something new. Throughout our day, we see, use, and even consume combinations of materials. It is useful to understand how materials will react when combined. This knowledge can even keep us safe.

Key words: atom, chemical, chemical change, chemical reaction, concentrated, density, electron, element, gas, liquid, magnetism, material, matter, mix, mixture, molecule, neutron, nucleus, physical change, property, proton, saturated, solid, solution, states of matter, substance, suspension, symbol, volume, weight

Key comprehension skill: Compare and contrast
Other suitable comprehension skills: Cause and effect; classify information; main idea and details; identify facts; elements of a genre; interpret graphs, charts, and diagrams

Key reading strategy: Visualize
Other suitable reading strategies: Ask and answer questions; summarize; connect to prior knowledge; using a table of contents and headings; using a glossary and boldfaced terms

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matter	anything that takes up space and has weight (p. 4)
mixtures	combinations of substances in which chemical reactions do not occur (p. 15)
molecule	the smallest part of a substance that can exist by itself, made of two or more atoms (p. 10)
neutrons	particles in the nucleus of an atom that have no electrical charge (p. 7)
nucleus	the positively charged central region of an atom, consisting of protons and neutrons, and containing most of the atom's mass (p. 7)
physical change	a change in the size, shape, or color of a substance that does not change it into a different substance (p. 12)

Glossary

atoms the smallest parts of an element (p. 7)

bond a connection between atoms that are joined together to form a molecule (p. 10)

chemical change a change in the chemical makeup of a substance (p. 12)

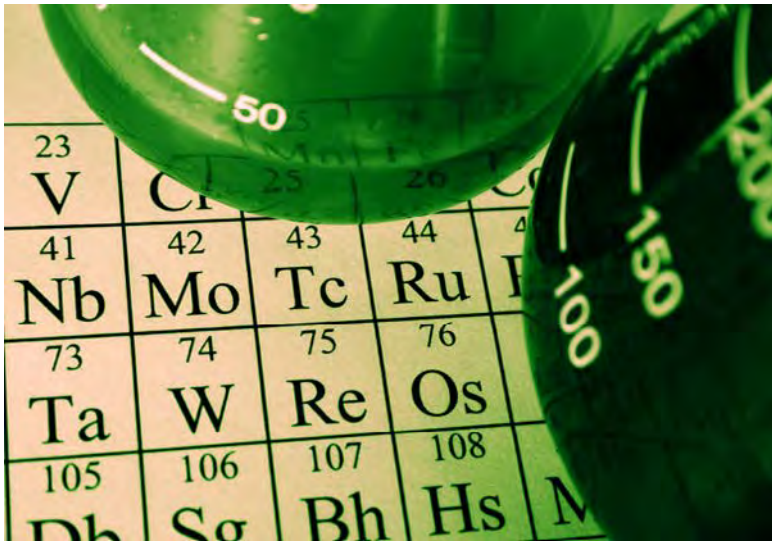
chemical reaction a process in which one substance is changed to another (p. 10)

compound a combination of two or more elements (p. 11)

concentrated how much of a substance is present in a solution (p. 16)

electrons particles that are part of an atom and that orbit the nucleus; they have a negative electrical charge (p. 7)

elements substances that cannot be broken down into simpler substances (p. 5)



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Introduction

Look at the things around you. Maybe you see books and a desk. What are they made of? The books are probably made of paper. The desk could be made of materials such as wood, glass, metal, or plastic. Maybe it's made of several materials put together. All these objects and materials are types of **matter**. Everything that takes up space and has weight is made of matter. But what is matter? This book explores the types of matter, how those materials can be mixed to make new things, and how matter can change.

Conclusion

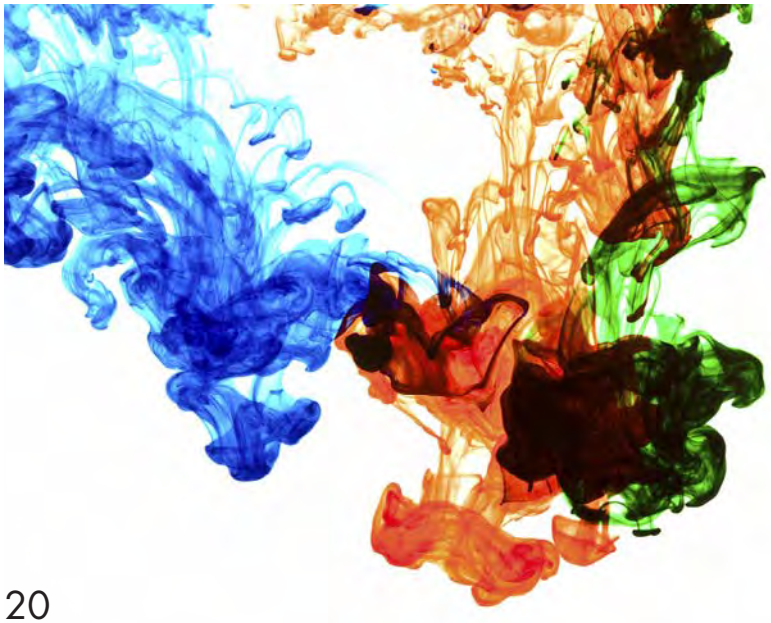
Everything we can see, touch, or smell is matter. And all matter is made from a small group of elements. These elements combine in many ways to make all the things you see around you.

Without elements and the many combinations they make, our world could not exist.

Mixing Liquids

Liquids can mix in different ways, too. Sometimes when you mix two liquids together, the liquids stay separate. If you mix oil and water, the oil rises and floats on top of the water.

In other liquid mixtures, the liquids do not stay separate. If you mix food coloring and water, the two liquids blend completely. It would be very hard to separate them.



Elements

All matter is made of simple materials called **elements**. An element is a substance that cannot be broken down into other substances. Imagine cutting a piece of gold into smaller and smaller pieces. No matter how small you make the pieces, each one will still be gold. That is why gold is an element.

Gold bar being poured

Pure gold is made only of gold particles.

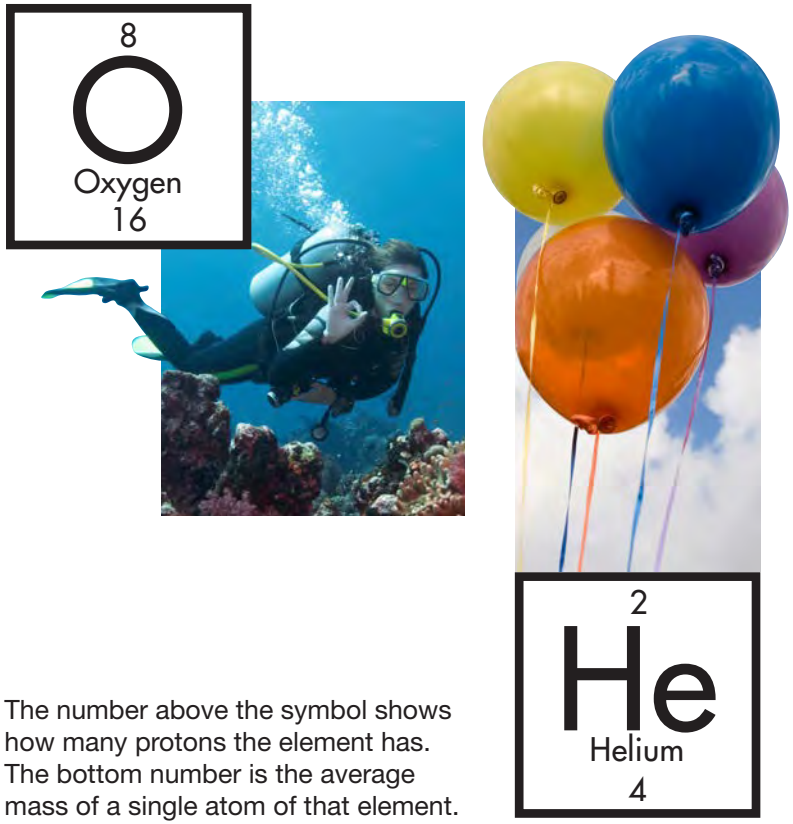
Word Wise

Some symbols for elements come from the Latin language. For example, *Fe* is the symbol for iron. *Fe* is short for *ferrum*, the Latin word for iron.

iron ore

There are about 120 elements. Some are metals, such as iron and gold. Others are usually gases, such as oxygen and helium. Each element has a symbol. The symbol is one or two letters that are often short for the element's name. For example, oxygen is "O" and helium is "He."

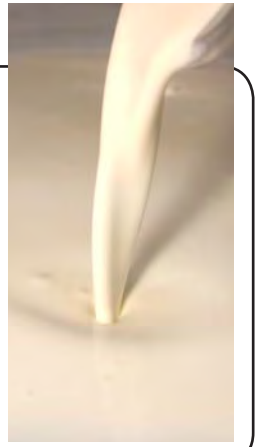
Elements combine in different ways to make materials that we see and use every day.



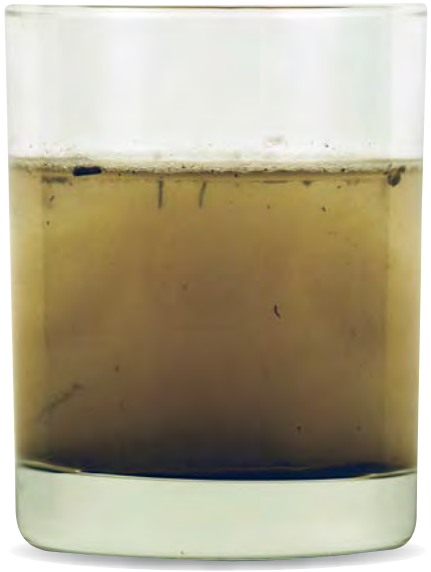
The number above the symbol shows how many protons the element has. The bottom number is the average mass of a single atom of that element.

Do You Know?

Cream is a special kind of suspension. It contains droplets of fats and bits of proteins suspended in water. If you were to shake some cream long enough, the droplets of fat would collect into a lumpy solid. That solid is butter!



A different kind of mixture of solids and liquids is called a **suspension**. In a suspension, the bits of solid material are very tiny and light. For that reason, they do not settle out right away.



If you stir some dirt into a glass of water, the tiniest particles form a suspension. They make the water brown. If the glass is not disturbed, the tiny bits of dirt slowly start to sink. Eventually, they all settle to the bottom of the glass.

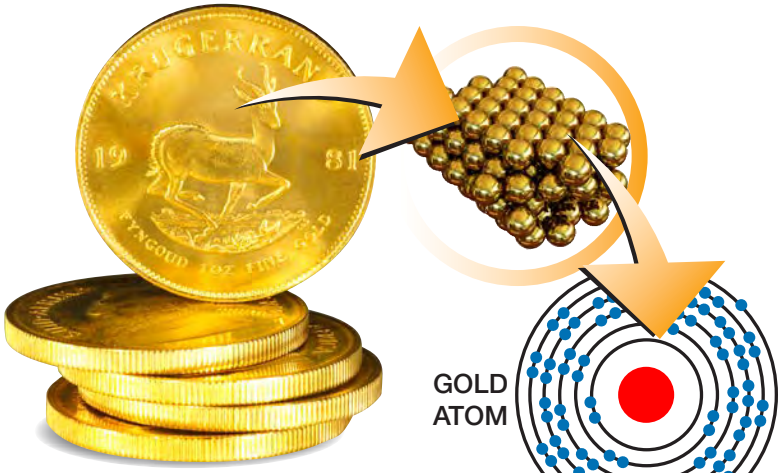
One way to tell the materials in a mixture apart is to look at the parts' properties, such as volume, density, and magnetism.

This table lists some properties of matter.

SOME PROPERTIES OF MATTER		
Property	**Definition**	**Discussion**
Volume	a measure of how much space something fills	Solids, liquids, and gases all take up space. It is impossible for one grain of sand to occupy the same space as another grain of sand.
Weight	a measure of how heavy something is	All matter has weight. Even a gas such as air has weight.
Density	a measure of how heavy something is compared to the volume it takes up	Almost all rocks are denser than water, so they sink when dropped into water. Most wood is less dense than water, so it floats in water.
Magnetism	the ability to be attracted by a magnet	Some matter, such as iron, is easily magnetized. Other types of matter, such as aluminum, wood, and paper, are not.

Atoms

Imagine that you could look deep inside any object. You would see that everything is made of tiny particles called **atoms**. Atoms are so small that they can only be seen with strong microscopes. Every element is made of a certain kind of atom. And no two elements have atoms that are the same. The smallest piece of gold is a gold atom.

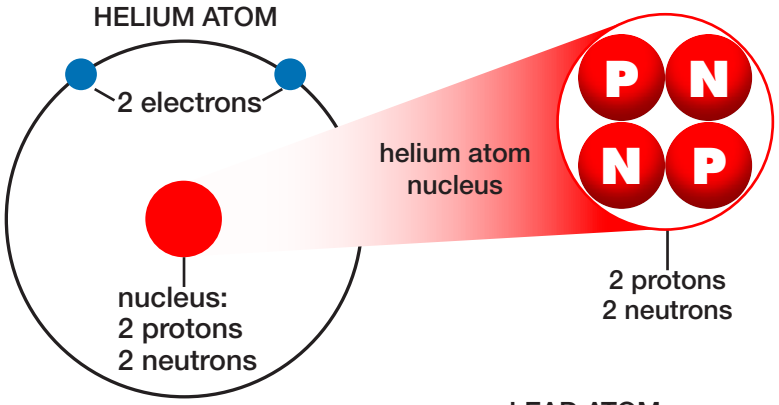


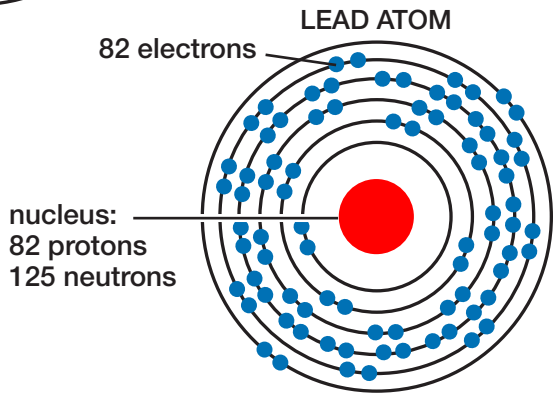
A gold coin is made of millions of gold atoms all packed together.

If you could look even deeper inside an atom, you'd see that it is made of even smaller particles. An atom is a little like the solar system. In the solar system, planets circle the Sun. In an atom, particles called **electrons** circle the center of the atom. The center of the atom is called the **nucleus**. Particles called **protons** and **neutrons** are found in the nucleus.

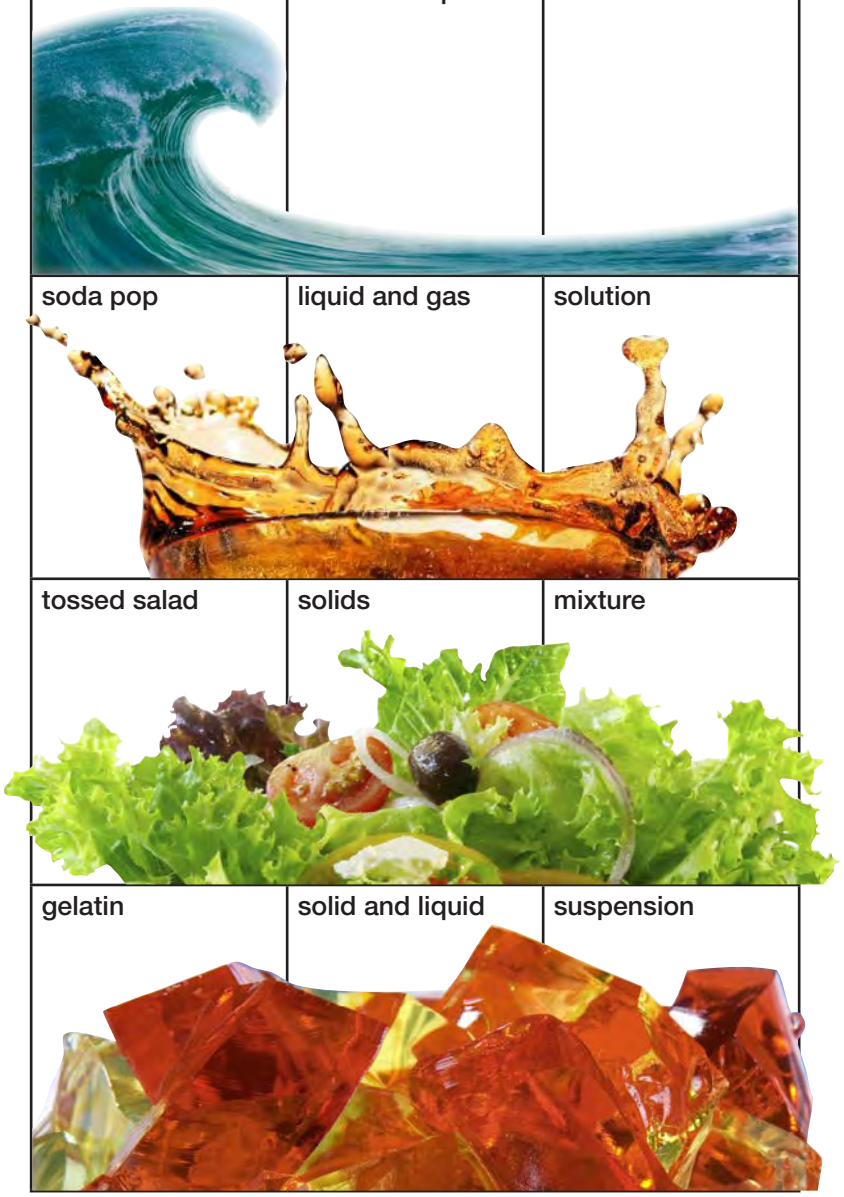
All atoms of the same element have the same number of protons and electrons. (The number of neutrons sometimes changes.) But atoms of different elements contain different numbers of protons and electrons.

Even though particles are far too tiny to see, they still weigh something. The more protons and neutrons an atom has, the more it will weigh. Helium atoms have just 2 protons and 2 neutrons in their nucleus. But lead has 82 protons and 125 neutrons. So lead is much heavier than helium.





COMMON MIXTURES, SOLUTIONS, AND SUSPENSIONS		
Substance	**States of Matter**	**Mixture, Solution, or Suspension**
salt water	solid and liquid	solution
soda pop	liquid and gas	solution
tossed salad	solids	mixture
gelatin	solid and liquid	suspension



Mixing Solids and Liquids

You can change the strength of a solution by adding more of the solid to the liquid. For example, to make a stronger cup of hot chocolate, you can add more chocolate powder. The hot chocolate is more **concentrated** when it has more chocolate powder.

However, there is a limit to the amount of a solid you can add to a liquid in a solution. If you add too much salt to water and shake it up, some of the salt will just sink to the bottom. If a solution cannot hold any more solid, it is **saturated**. You can add more salt to a saturated solution of salt water by heating the solution.

The more atoms an object has, the more it will weigh. An iron pan weighs less than an iron bridge. That's because a bridge has many billions more iron atoms than a pan.

The first iron bridge was built in England in 1779.

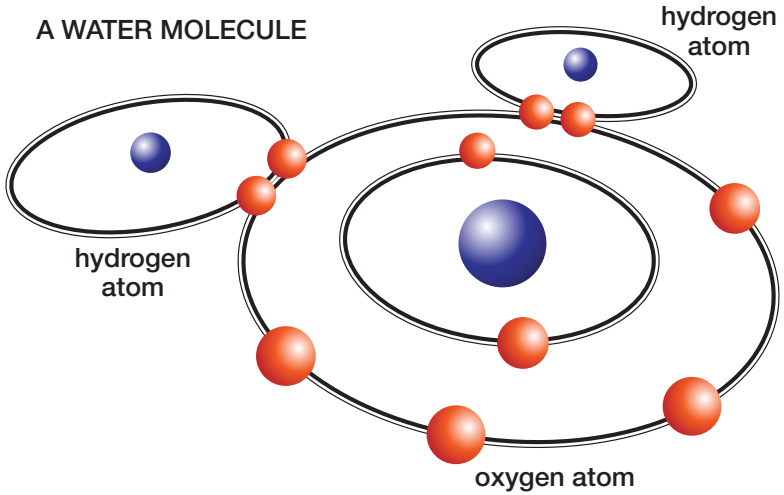
The ancient Greeks thought matter was made of just four elements. They said those elements were earth, air, fire, and water. In the 1600s, scientists began to learn that there are many elements. They soon realized that those elements are not earth, air, fire, or water.

Combining Matter

You've learned that there are about 120 elements. Each element is made of a different kind of atom. To create all the kinds of materials and objects you see every day, atoms come together in different combinations.

When atoms join, they share electrons. When they share electrons, they form a chemical **bond**. A bond can also be broken. When atoms form or break bonds with each other, it is called a **chemical reaction**.

The combination of two or more atoms is a **molecule**. A molecule is the smallest amount of most substances.



A water molecule has one oxygen atom and two hydrogen atoms. The hydrogen atoms share their electrons with the oxygen atom.

Mixing Matter

Now let's look at the physical changes that occur when matter is mixed together. Different states of matter can be mixed without causing a chemical change. You can mix solids with solids, solids with liquids, and liquids with liquids. You can mix gases with gases, and liquids with gases. These combinations of materials are called **mixtures**.

Sometimes it is easy to see the different materials in a mixture. For example, if you mix sand with water in a jar and shake it up, you just get cloudy-looking water. If you let the jar sit for a short time, the sand will easily separate and settle to the bottom of the jar.

At other times, different substances mix so well that it is hard to see the parts that were mixed. If you mix sugar or salt with water and shake it up, the salt or sugar dissolves and will not settle to the bottom if you let it sit. This kind of mixture is called a **solution**.

Sand mixed with water will settle out over time.

Cake batter is a simple mixture. But once it is baked, chemical changes happen.

When you bake a cake, you smell the cake baking, and you see the batter rise and turn brown. When the cake is sliced, you see a spongy texture. The texture is created by gas bubbles that formed in the batter. Before it is baked, cake batter is a simple physical mixture. Once the cake gets baked, chemical changes occur.

Do You Know?

Mercury *(Hg)* is an unusual element. It is a shiny liquid metal. You may have seen it in a thermometer. Mercury is the only metal that is a liquid at room temperature. It does not become a solid until it cools to about −39°C.

Rock candy is simply colored table sugar with large crystals.

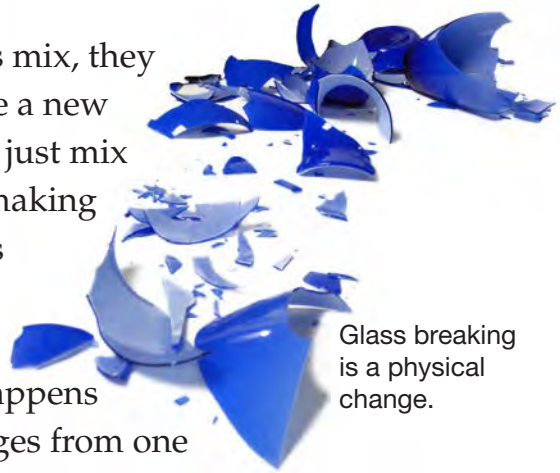
When two or more elements join, they make a **compound**. Each compound has its own properties. Salt and sugar look alike, but they are different compounds. The elements that combine to make salt and sugar have properties that make them taste different.

A compound can be very different from the elements it is made from. Water is made from two *gases!* Oxygen and hydrogen are usually gases. But when they join, they can make *liquid* water. Many other elements also bond to make new kinds of substances. Molecules can also bond together to form new kinds of molecules.

People name molecules and compounds using letters and numbers. The letters tell you which elements are in the molecule or compound. The numbers tell you how many atoms of each element are in the molecule or compound. For example, each water molecule has two hydrogen atoms and one oxygen atom. Water is H_2O.

Changing Matter

When materials mix, they don't have to make a new compound. If they just mix together without making a new material, it's called a **physical change**. Another physical change happens when matter changes from one state to another. For example, liquid water can change to solid ice, or from liquid to gas—those are both physical changes. If you add sugar to water, you get water that tastes sugary. But no new material is made.



Glass breaking is a physical change.

If materials combine chemically to make a new material, they undergo a **chemical change**. When oxygen in the air combines with iron, a chemical change happens. A new material, called *rust* or *ferric oxide*, is made. Rust is very different from oxygen or iron. The formation of rust is a chemical change.

Unpainted iron rusts faster than painted iron.

There are five main ways to tell when a chemical change happens.

1. *The material or mix changes color.* Apples turn brown due to a chemical reaction with the air.

2. *Energy is absorbed or released.* Many fireworks make light, heat, and sound when they burn.

3. *The material changes odor.* Food smells bad when it spoils because of chemical changes.

4. *The material or mix produces gases or solids.* If you drop an antacid tablet into water, it creates gas bubbles in the water.

5. *The change is difficult to undo.* If you bake a cake, it would be very hard to separate out its ingredients because they've undergone chemical changes.