# LESSON CLUSTER 2
# Other Solids, Liquids, and Gases

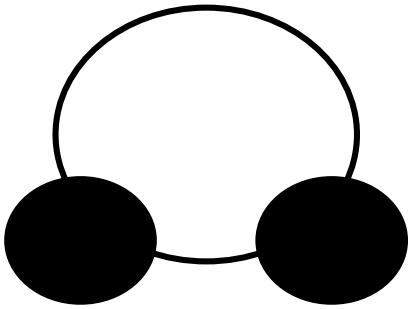
## Lesson 2.1: Are Other Substances Made Of Molecules?

In Lesson Cluster 1 you studied ice, water, and water vapor. All three states of water are made of the same kind of molecules--$H_20$. Each state has molecules arranged differently, but the molecules are the same. Water molecules are the building blocks for ice, water and water vapor.

If you look around, most of the substances you see are solids, liquids, or gases. Most substances can also change from one state to another. For example, lead is usually a solid, but if you heat it hot enough, it becomes a liquid. If you heat liquid lead very hot it becomes a gas. You can change the solid form of a substance into a liquid, or a liquid into a gas. It is possible to do this because all the states of a substance are made of the same kind of molecules.

You could never change ice into glass, though, or water into alcohol, or water vapor into oxygen gas. Even though these substances look similar and are in the same state, one cannot be changed into another? Do you know why?

The answer is that their molecules are different. Each substance is different from every other substance because each is made of its own kind of molecules. In the same way, we can classify all substances as either solid liquid, or gas, but that doesn't mean that all liquids are exactly alike. Each substance is made of its own kind of molecules, with a certain size, shape, and weight.

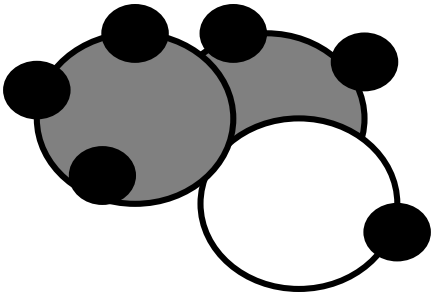


**Hydrogen** **Hydrogen**

*A molecule of water ($H_2O$)*

If we were able to see the molecules in a drop of pure water, (that is, water that is not dirty, or polluted) we would notice that all of the molecules of water would look exactly the same. They would all have the same structure.

If we could see the molecules of another substance, for example, alcohol, would these molecules look the same as the water molecules we just studied? No, the alcohol molecules are different from the water molecules. That's because each substance has its own kind of molecule, with a certain size, shape, and weight. The molecule of alcohol would look like this:



*A molecule of* *ALCOHOL: $CH_3\,CH_2\,OH$*

As you can see, an alcohol molecule looks very different from the molecules of water because it is made of different atoms. If we could use our magic eyeglasses to see the molecules in a drop of alcohol, we would see that all of the alcohol molecules have exactly the same shape, size, and weight.

The world is made of millions of different substances, and every substance is made of its own kinds of molecules! Some molecules, like water molecules, contain only a few atoms. Other molecules have hundreds or thousands of atoms. Even the largest molecules, though, are far too small to see.

Sugar is another substance you probably know. A sugar molecule is made of many atoms. (The formula is $C_{12}H_{22}0_{11}$). This is too complex to draw here. So in this unit, we will make-up a shape for a sugar molecule like this:

*A molecule of SUGAR: $C._{12}H_{22}O_{11}$*

All substances are made of molecules, but that doesn't mean that everything is made of molecules. Some things are not substances at all. Light, heat, and sound are not substances; they are forms of energy. Thoughts, love, and space are not substances either. Things that are not substances cannot be solids, liquids, or gases, and they are not made of molecules. There are no light molecules, or heat molecules, or sound molecules. There are no temperature molecules, or space molecules, or love molecules. Only matter exists as solids, liquids, and gases. Only matter is made of molecules.

Now try answering some questions about different substances and their molecules.

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Do Question Set 2.1 in your Activity Book

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## Lesson 2.2: Pure Substances and Mixtures

You learned in the last lesson that different substances are made of different kinds of molecules. Molecules of each substance have their own size, shape, and weight, and they are different from the molecules of all other substances. We can use this idea to help us study the difference between a pure substance and a mixture. We can tell a pure substance from a mixture by thinking about molecules.

A pure substance has only one kind of molecule. Pure substances can be solids, liquids, or gases. Pure sugar is an example of a pure substance. It is made only of sugar molecules. Lead, water, and alcohol are also pure substances. They each have only one kind of molecule.

A mixture has two or more different kinds of molecules mixed together. Mixtures can also be solids, liquids, or gases. The Kool-Aid that you drink is an example of a mixture: It contains water molecules and other molecules mixed together. Sometimes you can tell that something is a mixture by looking at it, but not always! Try making some mixtures and see!

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Do Activity 2.2 in your Activity Book

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It is easy to tell that some things are mixtures because you can see the separate particles: salt and pepper, for example. Sometimes, though, the substances when mixed together break up into individual molecules: sugar and water, for example. You can no longer see the different substances, but their molecules are still there, just all mixed together!

Most of the materials around us are mixtures, made of two or more different kinds of molecules. Very few substances are pure substances. Even substances that look pure may actually be mixtures.

For example, you might think that glass is a pure substance because it is clear, and you can see through it. But glass is actually a mixture of many different kinds of molecules. Milk is a mixture, and ocean water, too. Your body is a mixture containing thousands of different kinds of molecules.

What about air and water? Are they pure substances or mixtures? Water is a pure substance, made of only water molecules. Air, on the other hand, is a mixture, made of many different kinds of molecules mixed together. You will study more about air in Lesson Cluster 3, but for now the important point to remember is that it is very hard to tell whether a substance is a pure substance or a mixture just by looking at it, tasting it, or smelling it.

All pure substances are solids, liquids, or gases. But some mixtures such as muddy water are not easily classified as a solid, a liquid, or a gas. This is because mud contains solid particles of dirt mixed with liquid water. So mud is partly solid and partly liquid. Mud and many other mixtures contain two different states of matter.

Lesson 2.3: Molecules and States of Matter

In Lesson Cluster 1 you studied the three states of a single substance--water. In this lesson cluster you have studied several other substances: sugar, alcohol, oxygen, and so forth. Try using what you know about these substances to think about these questions:

How are all substances alike?
How are substances different from each other?

You might want to think about these questions for a minute before you read on.

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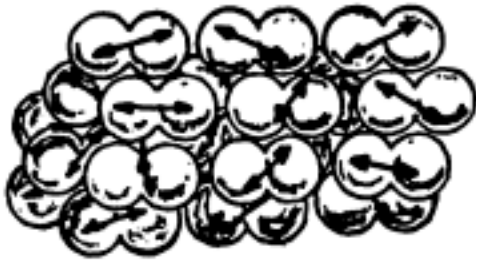
There are many possible answers to the above questions. Substances are alike and different in many ways. Here are three correct answers that are very important:

I. All substances are alike in that they are all made of molecules.
2. Substances are alike in that they are found in three basic states: Solid, liquid, and gas.
3. Different substances are made of different molecules. (Pure substances like water and sugar are made of only one kind of molecule. Mixtures like air and wood contain different kinds of molecules mixed together.)

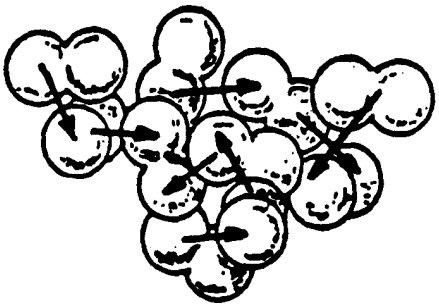
In this lesson you will be thinking about the molecules of solids, liquids, and gases. In what way are the molecules of all solids alike? In what ways are the molecules of different solids different? What about liquids and gases? You can think about these questions by discussing some substances that you are already familiar with.

Let's start with solids. Solids of different substances, like salt, steel, and sugar, are made of different kinds of molecules, but all solids are alike in the arrangement and motion of their molecules. All solids are made of molecules that are close together and locked into a rigid pattern. They move by vibrating in place and bumping into each other.



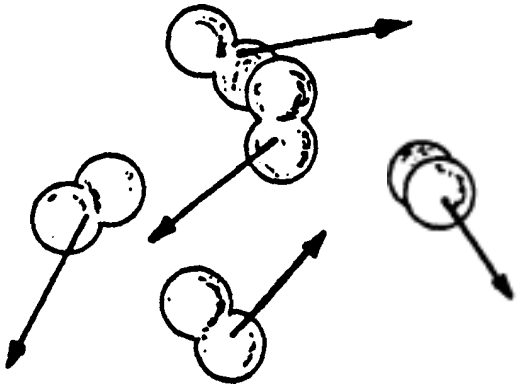
*The molecules of all solids are locked in a rigid pattern and vibrate in place*

Similarly, different liquids such as water, alcohol, and gasoline are made of different kinds of molecules, but all liquids are alike in the motion and arrangement of their molecules. All liquids are made of molecules that move around freely but stay close together. The molecules of liquids slide past each other and are constantly bumping into other molecules.



*The molecules of all liquids slide and bump past each other*

Different gases such as water vapor, oxygen, and carbon dioxide are made of different kinds of molecules, but all gases are also alike in the motion and arrangement of their molecules. All gases are made of molecules that are far apart from each other and moving freely through space. Sometimes gas molecules collide with other molecules or with objects.



*The molecules of all gases are far apart and bounce around freely*

Now you have learned a lot about solids, liquids, and gases of different substances. You have learned that all solids, liquids, and gases are made of molecules. Different substances are made of different kinds of molecules, but the motion and arrangement of molecules is about the same in all solids. All liquids also have molecules that move and are arranged in similar ways. So do all gases.

You also know that some substances are pure substances; all their molecules are the same. Most substances, though, are mixtures, of different kinds of molecules. In the next lesson cluster you will study a gas that is a mixture of several different kinds of molecules. We can't see this gas, but it is very important to us. The gas is air.

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Do Review Question Set 2.3 Now

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