Reflect

Everything around us is made out of tiny bits of matter. These particles may combine in different ways to produce new materials. Sometimes we need to separate the parts of a material. If we know how the small bits are combined, we can often figure out how to separate them.

matter: what is commonly called "stuff"; anything that has mass and takes up space

In this lesson, we will focus on three different types of materials. Some examples include pure water, sea water, and rocky soil. How are these materials similar? How are they different?

How is seawater different from pure water? How is it different from rocky soil?

Each of these materials is formed from different ingredients. We may separate these particles in different ways. How would you separate the parts that make up each material? How you plan to separate the parts will tell you more about the type of material.

Rocky road ice cream is a mixture. Combining marshmallows, almonds, and chocolate ice cream does not create a new kind of material.

What is a mixture?

First we must learn the difference between mixtures and compounds. Sometimes particles combine to form a completely new kind of material. The particles become connected in new ways that are difficult to undo. In these cases, we say a compound has formed.

Other times, particles do not form a new material when they combine. The connections between the particles are not difficult to undo. In these cases, we say a *mixture* has formed.

Making a mixture does not create a new material. This is true even when the mixture looks very

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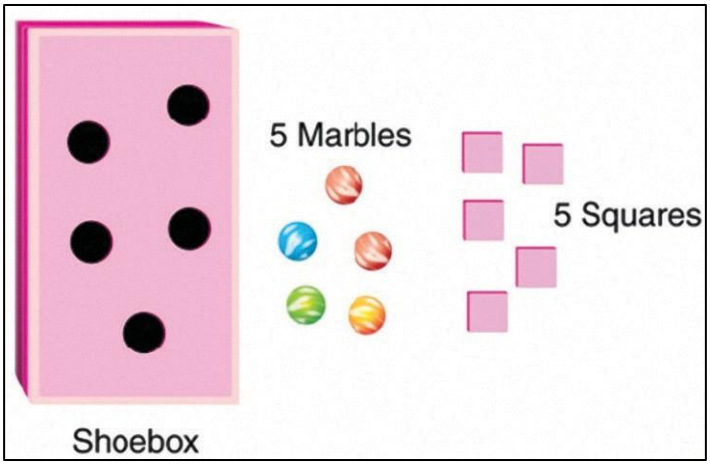
different from the particles combined to make it. Compared to compounds, mixtures can be unmixed pretty easily. Later in this lesson, you will learn how. How you decide to “un-mix” something reveals whether something is a true mixture.

Try Now

You will need some marbles, a shoebox, and something that can cut holes in the shoebox. Cut several round holes in the bottom of the box. Make the holes a little bigger than the marbles. Cut several squares out of the lid. The squares should be as wide as the marbles. The bottom of the box, the marbles, and the squares should look like this:



Put the marbles and the squares into the shoe box, creating a mixture. Then, shake the box back and forth. How will this help you to separate the marbles from the squares? What properties of the two shapes allow you to separate them?

Imagine adding a cup of cooking oil to a cup of water in a bottle. You screw the cap onto the bottle and shake the bottle. Now the liquid looks cloudy. Is this a mixture? When you let the bottle sit still for ten minutes, the oil rises to the top. Now you see a layer of water on the bottom and a layer of oil on top. But is this a mixture?

What is a solution?

We saw that materials can be either compounds or mixtures. However, scientists identify two different kinds of mixtures.

The mixture of marbles and squares in the “Try This” activity is one kind of mixture. In this kind of mixture, you can still see the bits of the materials that make up the mixture. The bits haven’t changed. They still look the same as they did at the beginning before you shook them up.

The ocean is a solution of salt dissolved in water.

What Do You Think?

Picture what happens when you mix salt with water. What about mixing sugar with water? The salt and sugar seem to disappear into the water. How is that possible? Things don't just disappear. The answer is that salt water and sugar water are examples of a different type of mixture called solutions. In a solution, the parts are mixed all the way down to the smallest particles. These particles are much too small to see, but they are still there. They haven't changed. Compared to the other kind of mixture, the parts in a solution are much more evenly and randomly mixed.

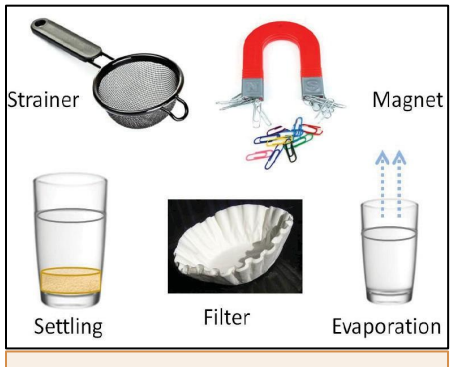
When materials like salt and sugar "disappear" into a liquid, we say they have dissolved. Later we will see how dissolved materials can be made to reappear. Solutions are separated in a different way from other mixtures.

Remember, mixtures and solutions are not separate things. A solution is one kind of mixture. All solutions are mixtures, but not all mixtures are solutions.

Look Out!

When ice melts, it changes to water. Sugar and salt can also melt if they get very hot. When they do, they become clear like water. When sugar and salt dissolve, they form clear solutions. Does this mean that melting is the same as dissolving?

Not at all! Melting is what is called a *change of state*. Solid, liquid, and gas are three different states of matter. Melting is a change from a solid state to a liquid state. Melting does not form a solution because only one material is there. Salt water and sugar water are mixtures because two materials are being mixed. Just because everything ends up as a liquid does not mean that anything has melted.



Mixtures can be separated in different ways.

How can materials in a mixture or solution be separated?
Some mixtures can be separated by *physical processes*. A physical process uses the physical properties of matter to separate a mixture. For example, you can separate a mixture of sand and rocks with a strainer. The sand will fall through the holes, and the rocks will stay in the strainer.

Look Out!

A strainer wouldn't separate a mixture of sawdust and sand because sawdust particles and sand particles are about the same size. To separate this mixture, you could dump it into a bucket of water. The sand would sink and the sawdust would float. Now think about sand mixed in water. How could you separate those items? Perhaps you could use a filter. A filter can separate a mixture of small bits like sand in a liquid. The paper in a filter has very small holes that let water pass through but not solid particles like sand. How about metal items? There are tools that can help us separate those items, too. A magnet can help us separate some types of mixtures. Magnets attract anything made of iron. You could use a magnet to separate pins from toothpicks.

What happens when water or a water solution is exposed to air? (A water solution is water with something dissolved in it.) Water molecules leave the liquid and move into the air as a gas. This process is called *evaporation*. As water evaporates, the dissolved material is left behind.

Solutions are usually separated by evaporation. Warming the liquid speeds up the evaporation process. If a solution of salt water or sugar water were allowed to completely evaporate, the salt or sugar would be visible at the bottom of the container. The salt and sugar particles would look much as they did before they were dissolved.

All the processes mentioned above are physical processes. The other kind of process is a *chemical* process. In a chemical process, a new material is formed. For example, hydrogen and oxygen are two pure gases that combine to form water. The water is not a mixture. It is a new material that is different from the beginning ingredients. The water can be separated into hydrogen and oxygen, but not by any *physical* process.

Looking to the Future: Drinking the Ocean

"Water, water, everywhere, nor any drop to drink." This is a line from a famous poem about sailors on a ship in the middle of the ocean who run out of water to drink. The sailors are surrounded by water, but they can't drink it because ocean water is salt water.

Look Out!

More and more people have a problem just like the sailors. Fresh water on Earth is running out. Some countries near the ocean have started to separate ocean water into salt and pure water to drink and water their crops. Separating salt from seawater is called *desalination*. We already learned that this can be done by evaporation. But we don't need to lose the evaporated water to the air. It can be recaptured as liquid water.

When you desalinate seawater using evaporation, you need a lot of heat. Producing heat is expensive. Most desalination happens in countries that have three things in common: They don't get much rain, they are near the ocean, and they have a lot of fuel to make heat.

It is important to find better, cheaper ways to desalinate water if we are going to solve Earth's fresh water shortage. Scientists are working hard to make evaporation cheaper and to find ways other than evaporation to remove salt from seawater.

What Do You Think?

Why is the ocean salty but rivers are not? Think about how water moves on Earth. The land contains many compounds, including salts. Rivers run over land to the sea. Water evaporates into the air where it forms clouds. Rain falls from the clouds and runs into the rivers.

What Do You Know?

A mixture contains these parts:

- Sand
- Sawdust
- Iron pieces
- Salt
- Glass marbles

Below are six steps in a process that can separate all the parts of this mixture. Put the steps in the correct order. Write a 1 in front of the first step, a 2 in front of the second step, and so forth. Also, write the part that will be separated as a result of each step. A few of the steps can happen at different times.

What Do You Think?

Order	Step	What part will it separate?
	Pour the mixture into a bucket of water.	
	Pass a magnet through the mixture.	
	Pass the mixture through a screen.	
	Evaporate the water.	
	Pour the mixture through a filter.	
	Remove material floating on the surface.	

Connecting With Your Child

Separating Mixtures by Evaporation

A solution is also called *a homogeneous mixture*. This means that the parts are thoroughly mixed and we don't usually see the separate parts easily. For example, when sugar dissolves in water, individual sugar particles separate from the larger sugar grains and become surrounded by water particles. Salt water is also a homogeneous mixture. The other type of mixture is a *heterogeneous mixture*. In this case, the individual bits of the components are larger than the small particles, as in a mixture of salt and sand. As a result, the ingredients are more clumped, or less random.

Solutions (homogeneous mixtures) are most easily separated by evaporation. This process allows the solvent (for example, water) to leave the solution and enter the atmosphere as gas molecules (for example, water vapor). This is how evaporation happens: In both pure water and in a water solution, particles of water are always passing back and forth between the liquid and the air at the surface. Evaporation happens when more molecules leave the solution than enter. Heat and surface area both increase the rate of evaporation. In the case of a solution, evaporation eventually leads to the loss of all the water, leaving behind the original dissolved material as a solid. This solid will be little changed from its original form before it was dissolved.

You can perform this activity with your child to observe the dissolution and recovery by evaporation of salt and sugar from a solution. Follow these steps:

1. Measure a sample of sugar and a sample of salt of equal size. If a scale or balance is available, make the samples of equal mass.
2. Add identical volumes of water to identical glasses.
3. Add the sugar sample to one glass and the salt sample to the other glass, and stir until dissolved. Observe any difference in the rate of dissolution.
4. Pour each solution into identical pie pans or other wide-mouth containers. Do not keep track of which is which.
5. Put the samples in a place where they are safe from contamination.
6. When all the water has evaporated, find the mass of the solids.
7. Ask your child to identify the samples. Which is the sugar, and which is the salt?

Here are some questions to discuss with your child:

1. Did the salt and sugar change in any way during the experiment?
2. Did a chemical change take place? Why or why not?
3. What physical changes occurred?
4. Can evaporation be used to separate a mixture of salt and sugar?