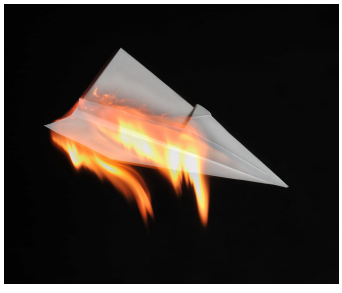
Reflect

Imagine that you took a full sheet of notebook paper to make a paper airplane. What would happen if you cut the notebook paper in half? You would have a smaller piece of paper, but you would still have paper. What do you have to do to the paper to make the airplane? What happens to the paper when you fold it? It takes on a different shape, but you still have paper.

Now, suppose you threw the paper airplane into a fire. What would happen to the paper? How would it change? How are changes caused by burning different from changes caused by cutting or folding?



Matter can undergo two types of changes: physical and chemical changes.

Physical changes involve changes to a substance's physical properties only. Some common physical changes are freezing, melting, evaporating, and dissolving. Making a paper airplane by folding the paper is a physical change. The paper does not undergo a chemical reaction—its chemical properties do not change. As with the paper airplane, you can undo a physical change fairly easily. To turn the paper airplane back into a sheet of paper, simply unfold the paper. To turn an ice cube back into liquid water, simply melt the ice cube.

Ice cubes melting to form liquid water is also a physical change.

Burning wood is a chemical change. Like burned paper, the wood changes to ash.

Chemical changes involve changes to the physical and chemical properties of a substance. During a chemical change, a new substance forms. Burning a piece of notebook paper changes the paper's physical and chemical properties. Initially, notebook paper is white; you can crumple and rip it, but it keeps its original color and composition. When the paper burns, however, it changes to black, flaky ashes. The ashes are a new type of substance that does not resemble the notebook paper. Unlike physical changes, a chemical change usually cannot be reversed. You cannot "unburn" the ashes to get back the original paper.

Mixing things can cause changes.
Combining substances can produce a mixture. For example, when you combine raisins, nuts, and chocolate candies, you produce a mixture. No chemical change takes place and no new substance is formed. However, when you combine baking soda and vinegar, a chemical reaction takes place and a new substance is formed that gives off gas bubbles.

Everyday life: rust is an example of a chemical change.

When a piece of iron or steel is exposed to water and oxygen over a long period of time, a chemical change occurs. You may be familiar with the **product** in this chemical change: rust. Objects made of iron, such as chains, automobiles, and bicycles, have certain physical properties in common. For example, iron objects are typically hard with shiny, metallic surfaces. When an iron object rusts, the object's properties change. Rust is a flaky, red substance that crumbles easily.

product – the result of a chemical change

The nails on the right have rusted. The nails on the left have not. How does rusting change the properties of nails?

There are ways to prevent rust. In many places when it snows, people put salt on the roads to keep ice from forming. However, salt also speeds up the process of rusting. Cars driving on salt-covered roads are more likely to rust. Washing salt off cars helps slow this chemical change. In addition, people use special chemicals to coat boats and other metals that are exposed to salt water. These chemicals create a barrier that protects the metal from the salt. Painting an object made of iron or steel can also provide a barrier to water and oxygen in the air. (The most common place for rust to form on an automobile is where the paint has chipped off the surface.)

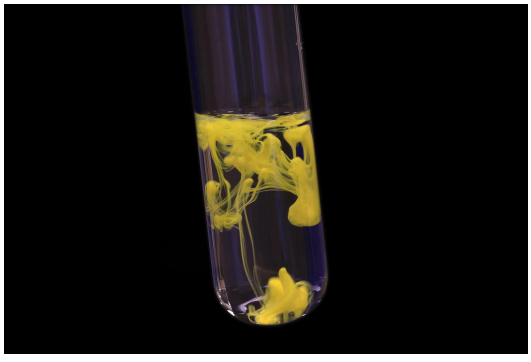
We can identify evidence of chemical changes.

There are several signs that provide evidence of a chemical change. A chemical change may not show all these signs, but one or more of these is strong evidence that a chemical change has occurred. The only way to know for sure that a chemical change has occurred is to determine if a new substance with new properties has formed.

Let's take a closer look at what you might see when a chemical change happens.

- **Production of a gas**: When a gas is produced in a reaction involving a liquid, bubbles form. If you mix two common household items, baking soda and vinegar, a chemical change occurs. During the process, the bubbles that you see are particles of carbon dioxide gas being produced. Carbon dioxide was not there before—it formed due to chemical changes to the baking soda and vinegar.

- **Change in temperature**: Chemical changes can either give off heat or absorb heat. When a log burns, a large amount of heat is given off. When food is cooked, there is a temperature change. A temperature change is evidence of a chemical change. Other chemical changes absorb heat. Some "ice" packs contain chemicals that absorb heat and feel colder when they react. When you bend the pack, you cause the chemicals to mix together and react. As a result, the pack becomes cold, like ice.



- **Formation of a precipitate**: A *precipitate* is a solid substance that forms when two liquids are combined. A precipitate often settles to the bottom of a liquid reaction. When milk and lemon juice combine, a chemical change called *curdling* occurs, and a precipitate forms. The mixture forms a chunky, solid substance. This precipitate is evidence of a chemical change.

- **Change in color**: A sliced apple that is left out on the table turns brown over time. This is because of a chemical reaction that occurs between the apple and oxygen in the air. The change in color from white to brown provides evidence that a chemical reaction has happened. Note: painting to change color is just a physical change.

Look Out!

Some physical changes may at first seem like chemical changes. They could have some signs of a chemical change! For example, when you boil water, the liquid water turns into the gaseous form of water, water vapor, and the temperature increases. You may think that a chemical change has happened because a liquid has become a gas. However, a new substance has not formed—water vapor is still water.

The change from liquid water to water vapor is an example of a phase change. A phase change (also called a *change in state*) is reversible—you can turn water vapor back into liquid water by cooling it.

So, how can you know what type of change has happened? You can know a chemical change happened if a brand-new substance was formed.