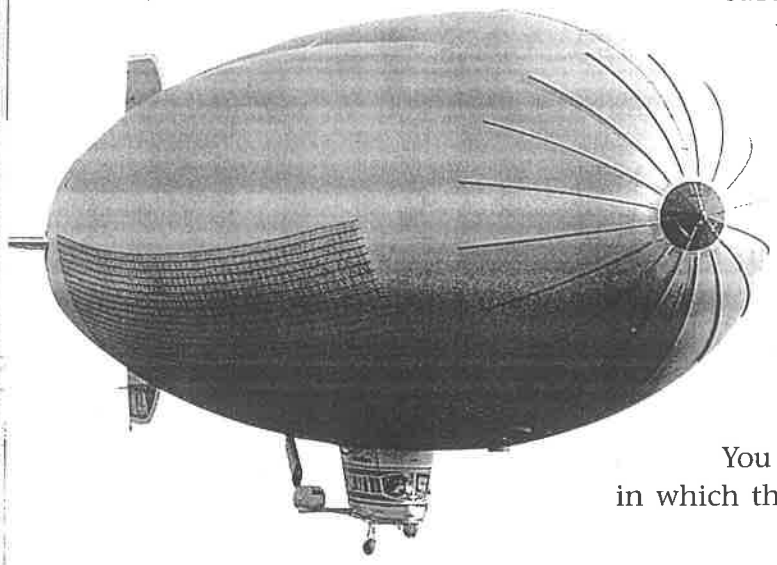
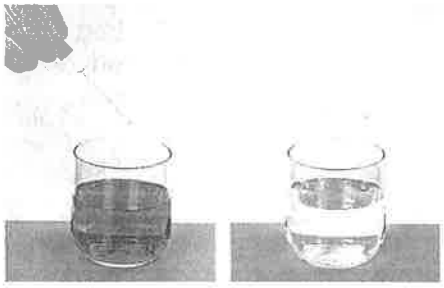
Physical Vs. Chemical Properties

Figure 14 *Substances have different physical and chemical properties.*



a Helium is used in airships because it is less dense than air and is nonflammable.



b If you add bleach to water that is mixed with red food coloring, the red color will disappear.

You can describe matter by both physical and chemical properties. The properties that are most useful in identifying a substance, such as density, solubility, and reactivity with acids, are its characteristic properties. The *characteristic properties* of a substance are always the same whether the sample you're observing is large or small. Scientists rely on characteristic properties to identify and classify substances. **Figure 14** describes some physical and chemical properties.

It is important to remember the differences between physical and chemical properties. For example, you can observe physical properties without changing the identity of the substance. You can observe chemical properties only in situations in which the identity of the substance could change.

Comparing Physical and Chemical Properties

Substance	Physical property	Chemical property
Helium	less dense than air	nonflammable
Wood	grainy texture	flammable
Baking soda	white powder	reacts with vinegar to produce bubbles
Powdered sugar	white powder	does not react with vinegar
Rubbing alcohol	clear liquid	flammable
Red food coloring	red color	reacts with bleach and loses color
Iron	malleable	reacts with oxygen

Physical Changes Don't Form New Substances

A **physical change** is a change that affects one or more physical properties of a substance. For example, if you break a piece of chalk in two, you change its physical properties of size and shape. But no matter how many times you break it, chalk is still chalk. The chemical properties of the chalk remain unchanged. Each piece of chalk would still produce bubbles if you placed it in vinegar.

Examples of Physical Changes Melting is a good example of a physical change, as you can see in **Figure 15.** Still another physical change occurs when a substance dissolves into another substance. If you dissolve sugar in water, the sugar seems to disappear into the water. But the identity of the sugar does not change. If you taste the water, you will also still taste the sugar. The sugar has undergone a physical change. See the chart below for more examples of physical changes.

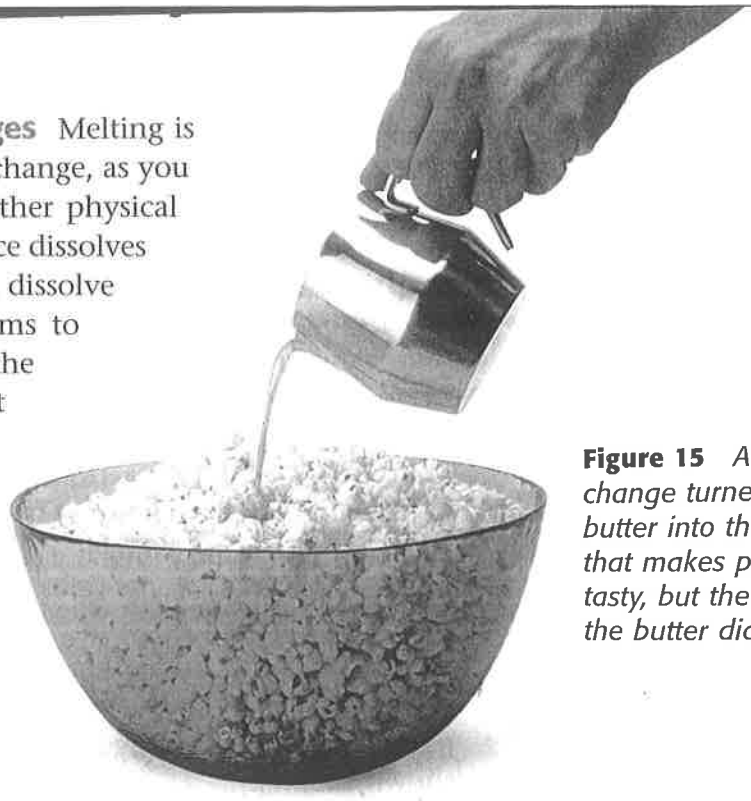


Figure 15 *A physical change turned a stick of butter into the liquid butter that makes popcorn so tasty, but the identity of the butter did not change.*

More Examples of Physical Changes

- Freezing water for ice cubes
- Sanding a piece of wood
- Cutting your hair
- Crushing an aluminum can
- Bending a paper clip
- Mixing oil and vinegar

Can Physical Changes Be Undone? Because physical changes do not change the identity of substances, they are often easy to undo. If you leave butter out on a warm counter, it will undergo a physical change—it will melt. Putting it back in the refrigerator will reverse this change. Likewise, if you create a figure from a lump of clay, you change the clay's shape, causing a physical change. But because the identity of the clay does not change, you can crush your creation and form the clay back into its previous shape.

Chemical Changes Form New Substances

A **chemical change** occurs when one or more substances are changed into entirely new substances with different properties. Chemical changes will or will not occur as described by the chemical properties of substances. But chemical changes and chemical properties are not the same thing. A chemical property describes a substance's ability to go through a chemical change; a chemical change is the actual process in which that substance changes into another substance. You can observe chemical properties only when a chemical change might occur.

Quick Lab

Changing Change

1. Place a folded **paper towel** in a **small pie plate.**
2. Pour **vinegar** into the pie plate until the entire paper towel is damp.
3. Place **two or three shiny pennies** on top of the paper towel.
4. Put the pie plate in a place where it won't be bothered, and wait 24 hours.
5. Describe the chemical change that took place.
6. Write your observations in your ScienceLog.

Figure 16 *Each of these ingredients has different physical and chemical properties.*

A fun (and delicious) way to see what happens during chemical changes is to bake a cake. When you bake a cake, you combine eggs, flour, sugar, butter, and other ingredients as shown in **Figure 16.** Each ingredient has its own set of properties. But if you mix them together and bake the batter in the oven, you get something completely different. The heat of the oven and the interaction of the ingredients cause a chemical change. As shown in **Figure 17,** you get a cake that has properties completely different to any of the ingredients. Some more examples of chemical changes are shown below.

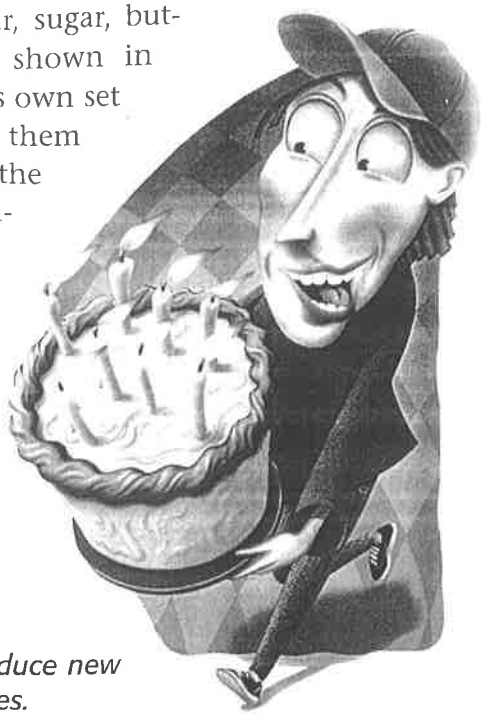


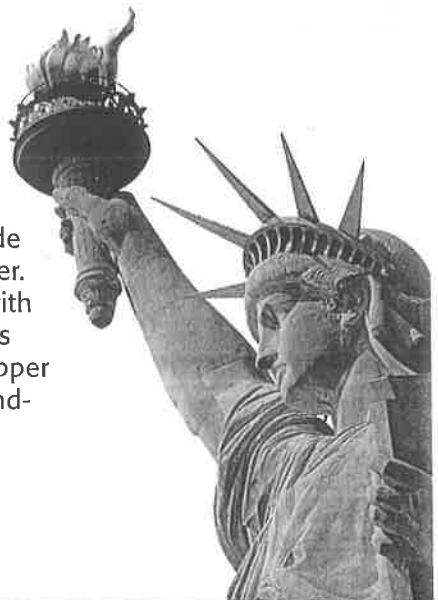
Figure 17 *Chemical changes produce new substances with different properties.*

Examples of Chemical Changes

Soured milk smells bad because bacteria have formed new substances in the milk.

Effervescent tablets bubble when the citric acid and baking soda in them react with water.

The hot gas formed when hydrogen and oxygen join to make water helps blast the space shuttle into orbit.



The Statue of Liberty is made of shiny, orange-brown copper. But the metal's interaction with carbon dioxide and water has formed a new substance, copper carbonate, and made this landmark lady green over time.

Clues to Chemical Changes Look back at the bottom of the previous page. In each picture, there is at least one clue that signals a chemical change. Can you find the clues? Here's a hint: chemical changes often cause color changes, fizzing or foaming, heat, or the production of sound, light, or odor.

In the cake example, you would probably smell the sweet aroma of the cake as it baked. If you looked into the oven, you would see the batter rise and turn brown. When you cut the finished cake, you would see the spongy texture created by gas bubbles that formed in the batter (if you baked it right, that is!). All of these yummy clues are signals of chemical changes. But are the clues and the chemical changes the same thing? No, the clues just result from the chemical changes.

Can Chemical Changes Be Undone? Because new substances are formed, you cannot reverse chemical changes using physical means. In other words, you can't uncrumple or iron out a chemical change. Imagine trying to un-bake the cake shown in **Figure 18** by pulling out each ingredient. No way! Most of the chemical changes you see in your daily life, such as a cake baking or milk turning sour, would be difficult to reverse. However, some chemical changes can be reversed under the right conditions by other chemical changes. For example, the water formed in the space shuttle's rockets could be split back into hydrogen and oxygen using an electric current.

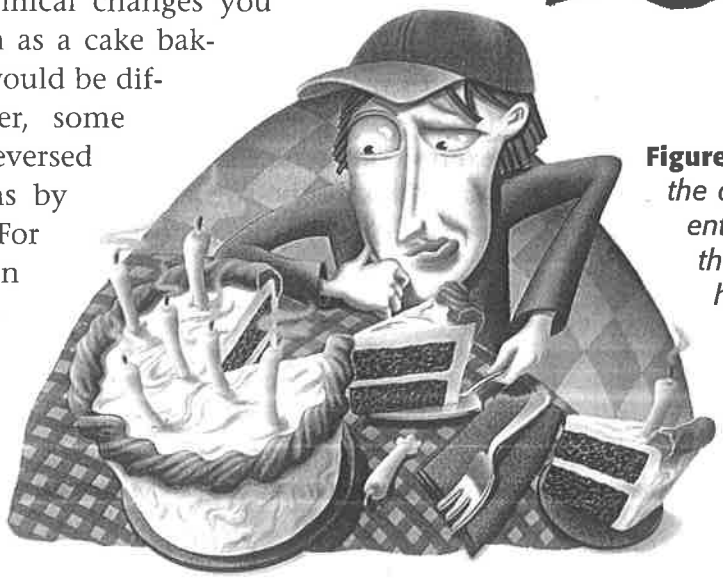


Figure 18 *Looking for the original ingredients? You won't find them—their identities have changed.*

Environment CONNECTION

When fossil fuels are burned, a chemical change takes place involving sulfur (a substance in fossil fuels) and oxygen (from the air). This chemical change produces sulfur dioxide, a gas. When sulfur dioxide enters the atmosphere, it undergoes another chemical change by interacting with water and oxygen. This chemical change produces sulfuric acid, a contributor to acid precipitation. Acid precipitation can kill trees and make ponds and lakes unable to support life.

REVIEW

1. Classify each of the following properties as either physical or chemical: reacts with water, dissolves in acetone, is blue, does not react with hydrogen.
2. List three clues that indicate a chemical change might be taking place.
3. Comparing Concepts Describe the difference between physical changes and chemical changes in terms of what happens to the matter involved in each kind of change.

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