

Chapter 17 Physical or Chemical Properties

Section 17.1 Physical and Chemical Properties

Terms:

- **Physical Property**
- **Physical Change**
- **Chemical Property**
- **Chemical Change**
- **Law of Conservation of Mass**

Physical Properties

You can bend an empty aluminum can, but you can't bend a piece of chalk. Chalk doesn't bend—it breaks. Brittleness is a characteristic that describes chalk. Its color and shape also describe the chalk. Any such characteristic of a material that you can observe without changing the substances that make up the material is a **physical property**. Examples of physical properties include: color, shape, size, density, melting point, and boiling point.

Some physical properties describe the appearance of an object. For example, you might describe an iron nail as a pointy-ended cylinder made of a dull, gray-colored solid. By describing the shape, color, and state of the nail, you have listed several of its physical properties. Some physical properties can be measured. For instance, you could use a metric ruler to measure one property of the nail—its length. What physical property of the nail is measured with a balance?

If you had a soft drink in a cup, you could measure its volume and temperature and describe its odor. Each of these characteristics is a physical property of the soft drink. Some physical properties describe the behavior of a material or a substance. As you may know, a magnet attracts all objects made of iron. Attraction by a magnet is a property of the substance iron. Every substance has physical properties that distinguish it from other substances.

Identification by Properties Do you pick out the grapes in a fruit salad and eat them first, last, or maybe not at all? If you do, you are using physical properties to identify the grapes and separate them from the other fruits in the mixture. The left figure shows a jar of pebbles and sand. You can identify the pebbles and grains of sand by differences in color, shape, and size. By sifting the mixture, you can

quickly separate the pebbles from the grains of sand because they are different sizes.

Now look at the picture of iron filings and sand. It would be impossible to separate this mixture with a sieve because the filings and grains of sand are the same size. A more efficient way is to pass a magnet through the mixture. When you pass a magnet through a mixture containing iron, the magnet attracts the iron filings and pulls them from the sand. In this way, the difference in a physical property, such as attraction to a magnet, can be used to separate substances in a mixture. A practical example of using the physical property of magnetism is shown below.

Physical Changes

If you break a piece of chalk, its original size and shape change. You have caused a change in some of its physical properties. But you have not changed the identity of the substance that makes up the chalk. The changes in state are also examples physical changes. When a substance freezes, boils, evaporates, sublimates, or condenses, it undergoes physical changes. Energy changes occur during these changes in state, but the kind of substance—the identity of the element or compound—does not change.

The Identity Remains the Same As shown in the picture above, iron will change states if it absorbs or loses enough energy. In each state, it will have physical properties that identify it as the substance iron. A change in size, shape, or state of matter is called a **physical change**. Sometimes, a color change indicates a physical change. Physical changes do not change the identities of the substances in a material.

Just as physical properties can be used to separate mixtures, so can physical changes. For example, if you let a cup of salt water stand for a week, you'll find that the water has evaporated, leaving salt crystals inside the cup. The process of evaporating water from salty seawater is used to produce drinking water.

Chemical Changes

From observations of what happens around you, you know that changes do occur in which substances change their identities. Fireworks explode, matches burn, eggs rot, and bikes and car bodies rust. What do changes in these materials have in common?

Burned toast, burned soup, and burned steak all smell burned. The smell is different from the smell of bread, soup, or steak. The odor is a clue that a new

substance has been produced. A change in one substance in a material to a different substance is a **chemical change**. Many signs can tell you when a chemical change has taken place. For example, the foaming of an antacid tablet in a glass of water and the smell in the air after a thunderstorm indicate that new substances have been produced. In some chemical changes, a rapid production of energy, such as the light and sound of an exploding firecracker, is a clue.

A Change in Identity

When iron is exposed to the oxygen and water in the air, the iron and oxygen slowly form a new substance, rust. When hydrogen gas is burned in a rocket engine, the elements hydrogen and oxygen combine to form water. Burning and rusting are chemical changes because different substances are produced.

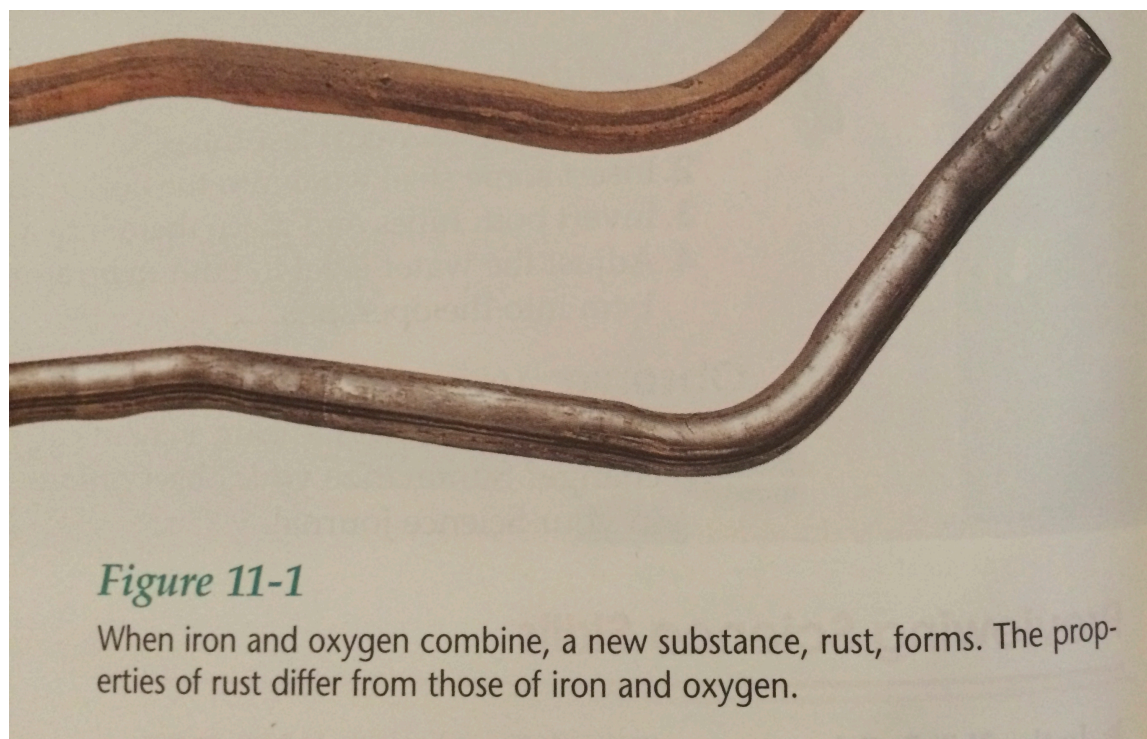


Figure 11-1

When iron and oxygen combine, a new substance, rust, forms. The properties of rust differ from those of iron and oxygen.

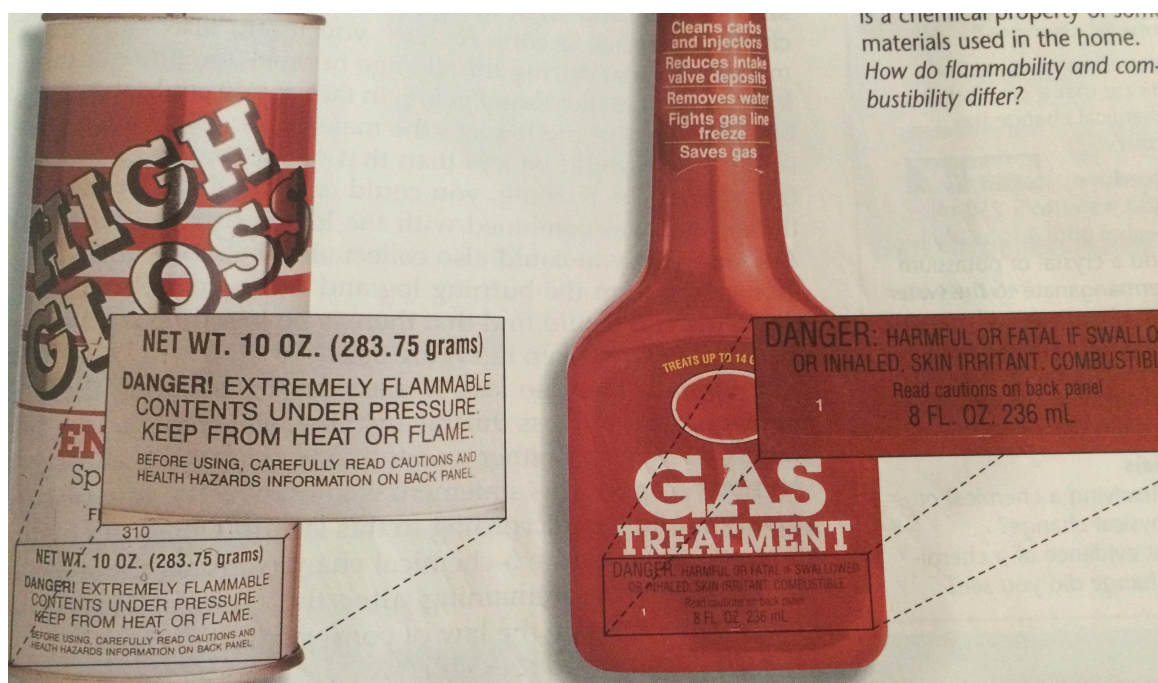
Weathering: Chemical or Physical Change? The effect of nature's forces on Earth's surface provides many opportunities to observe dramatic changes. Steep canyon walls, shifting sand dunes, and unusual limestone formations are easily observed at various global locations. Would you classify the changes that caused these formations physical changes or chemical changes? Geologists, using the same criteria that you have learned in this chapter, would classify some weather changes as physical and some as chemical.

Large rocks can split when water seeps into small cracks, freezes, and expands. However the smaller pieces of newly exposed rock still have the same properties as the original sample. This change is a physical change.

Rain and moving rivers may wash limestone, shown in the left image, away, which is another physical change. Sometimes, however, the water is acidic. If this is the case, the changes may produce new products. Solid calcium carbonate, a compound found in limestone, does not easily dissolve in water. But when calcium carbonate reacts with an acid, it changes into a new substance, calcium hydrogen carbonate that can dissolve in water. This change in limestone would be classed as a chemical change because the identity of the calcium carbonate changes. The mineral feldspar is also susceptible to acid attack.

Chemical Properties

Look at the figure below. You have probably seen these warning on cans of paint thinners and lighter fluids for charcoal grills. The warnings indicate that these liquids burn quickly. The tendency of a substance to burn is an example of a chemical property. A **chemical property** is a characteristic of a substance that indicates whether it can undergo a certain chemical change. Many substances are flammable or combustible. Knowing which materials contain substances that have this chemical property allows you to use them safely.



If you look around a drugstore, you might notice that many medicines are stored in dark bottles. These medicines contain compounds with a similar chemical property. Chemical changes will take place in the compounds if they are exposed to light. What physical property do these bottles have in common?

Even though there are thousands of substances and billions of mixtures, they do

share a few common physical and chemical properties. You can use these properties to study matter further.

The Conservation of Mass

Wood is combustible, or burnable, which is a chemical property. Suppose you burn a large log on a campfire until nothing is left but a small pile of ashes. During the burning, smoke, heat and light are given off. It's easy to see that a chemical change occurs. At first, you might also think that matter was lost or destroyed during this change because the pile of ashes looks much smaller than the log. In fact, if you could measure both the mass of the log and the mass of the ashes, the mass of the ashes would be less than that of the log. But suppose that during the burning, you could collect all the oxygen in the air that was combined with the log during the burning. And suppose you could also collect all the smoke and gases that escape from the burning log and measure their masses, too. Then you would find that there is no loss of mass during the burning!

Not only is there no loss of mass during burning, there is no loss or gain of mass during any chemical change. In other words, matter is neither created nor destroyed during a chemical change. This statement is known as the **law of conservation of mass**. According to this law, the mass of all substances present before a chemical change equals the mass of all the substances remaining after the change.

Why do substances have physical and chemical properties and undergo physical and chemical changes? These properties and changes are the result of what atoms are present and how they are arranged. The composition and arrangement are different for each substance.

Summary:

- **Physical properties are characteristics of materials that you can observe without change the identities of the substances themselves.**
- **In physical changes, the identities of substances in materials do not change. In chemical changes, substances in materials change to different substances.**
- **Physical properties can be observed without changing the identities of substances; chemical properties indicate chemical changes substances can undergo.**
- **The law of conservation of mass states that during any chemical change, matter is neither created nor destroyed.**