

Properties and Changes of Matter

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CONCEPT

1

Properties and Changes of Matter

Lesson Objectives

The student will:

- explain the difference between physical and chemical properties of matter.
- list examples of physical properties.
- list examples of chemical properties.
- classify properties as chemical properties or physical properties.
- explain the difference between physical and chemical changes in matter.
- list examples of physical changes.
- list examples of chemical changes.
- classify changes as physical changes or chemical changes.

Vocabulary

- chemical change
- chemical property
- physical change
- physical property

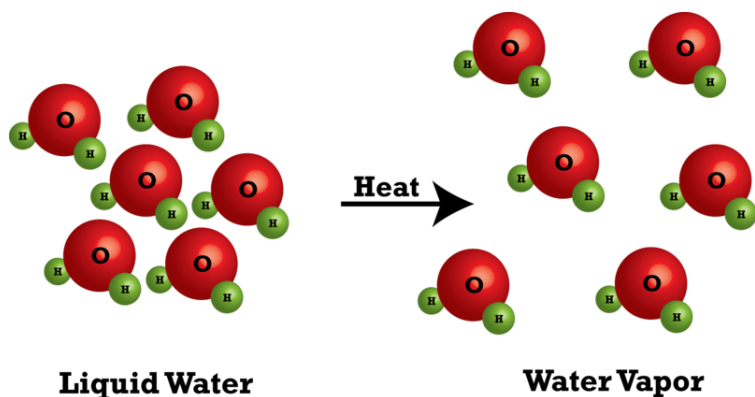
Introduction

What kinds of properties do chemists actually measure in the laboratory? Well, you can probably guess a few. Imagine that you are having dinner at a friend's house and are served something that you don't recognize. What types of observations might you make to determine what you've been given? You might note the smell or color of the food. You might observe whether the food is a liquid or a solid. You could also pick up a small amount of food with your fork and try to figure out how much it weighs. A light dessert might be something like an angel cake, while a heavy dessert is probably a pound cake. You might also want to know something about the food's texture. Is it hard and granular like sugar cubes, or soft and easy to spread like butter?

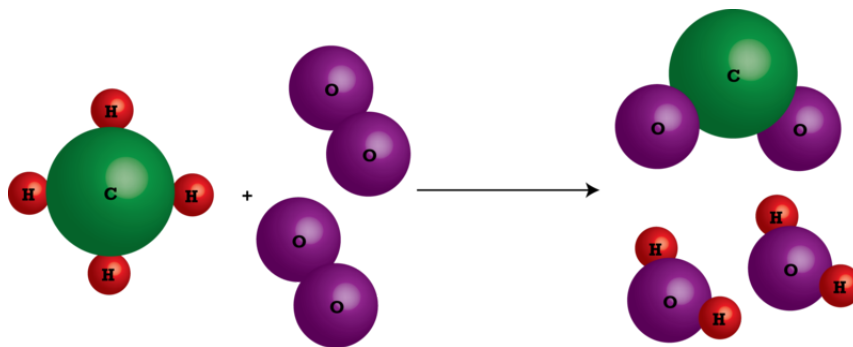
Believe it or not, the observations you are likely to make when trying to identify an unknown food are very similar to the observations that a chemist makes when trying to learn about a new material. In general, chemists are interested in characteristics that you can test and observe, such as a chemical's smell or color, and characteristics that are far too small to see, such as what the oxygen you breathe in or the carbon dioxide you breathe out looks like. Chemists rely on color, state (solid, liquid, or gas), temperature, volume, mass, and texture. There is, however, one property you might use to learn about a food but that you should definitely not use to learn about a chemical – taste!

Physical and Chemical Properties

There are two basic types of properties that are used to identify or describe matter: physical properties and chemical properties. **Physical properties** are properties that can be observed without changing the identity of the substance. In the image below, we have water molecules that are held in liquid form on the left. Each molecule contains two atoms of hydrogen chemically bonded with one atom of oxygen. When we heat the liquid water, it changes to water vapor. The physical properties change - we can see the liquid water, but the water vapor cannot be seen. Liquid water has a higher density than water vapor, and so on. But even though the physical properties have changed, the molecules are exactly the same as before. Each water molecule still contains two hydrogen atoms and one oxygen atom chemically bonded together.



On the other hand, **chemical properties** can only be observed when a substance is changed into a new substance. In the image below, on the left we have a molecule of methane (CH_4) and two molecules of oxygen (O_2). On the right, we have two molecules of water (H_2O) and one molecule of carbon dioxide (CO_2). In this case, not only has the appearance changed, but the structures of the molecules have also changed. The new substances do not have the same chemical properties as the original ones. Therefore, this is a chemical change. The chemical properties, such as how they react and what they react with, however, will still be the same as before.



Physical and Chemical Changes

Chemists make a distinction between two different types of changes that they study: physical changes and chemical changes. **Physical changes** are changes that do not alter the identity of a substance. Some types of physical changes include:

- changes of state (changes from a solid to a liquid or a gas, and vice versa)

- separation of a mixture
- physical deformation (cutting, denting, stretching)
- making solutions (special kinds of mixtures)

If you have a jar containing a mixture of pennies and nickels and you sort the mixture so that you have one pile of pennies and another pile of nickels, you have not altered the identity of either the pennies or the nickels. You've merely separated them into two groups. Similarly, if you have a piece of paper and you rip it up, you don't change the paper into something other than a piece of paper. These are examples of a physical change. For the most part, physical changes tend to be reversible, or capable of occurring in both directions. You can turn liquid water into solid water (ice) through cooling, and you can also turn solid water into liquid water through heating (**Figure 1.1**).



FIGURE 1.1

Melting snow is an example of a physical change.

Chemical changes are changes that occur when one substance is turned into another substance. Chemical changes are frequently harder to reverse than physical changes. One good example of a chemical change is burning paper. In contrast to the act of ripping paper, the act of burning paper actually results in the formation of new chemicals (carbon dioxide and water, to be exact). Notice that whereas ripped paper can be at least partially reassembled, burned paper cannot be “unburned.” In other words, burning only goes in one direction. The fact that burning is not reversible is another good indication that it involves a chemical change. Another example of a chemical change, illustrated in **Figure 1.2**, is the explosion of fireworks.

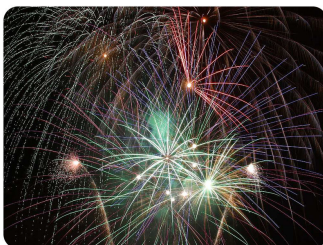


FIGURE 1.2

Fireworks are an example of a chemical change.

Lesson Summary

- There are two basic types of properties that are used to identify or describe matter: physical properties and chemical properties.

- Physical properties are those that can be observed without changing the identity of the substance.
- Chemical properties are those that can be observed only when a substance is changed into a new substance.
- Chemists make a distinction between two different types of changes that they study: physical changes and chemical changes.
- Physical changes are changes that do not alter the identity of a substance
- Chemical changes are changes that occur when one substance is turned into another substance.
- Chemical changes are frequently harder to reverse than physical changes.

Further Reading / Supplemental Links

This website provides some free PowerPoint presentations. The presentation on "Matter and Energy" provides a review of some properties of matter, as well as provide examples of the topics covered in this lesson.

- <http://science.pppst.com/energy.html>

Review Questions

For questions 1-2, determine whether the description is of a physical property or a chemical property.

1. Water boils at 100°C.
 - a. This is a physical property.
 - b. This is a chemical property.
2. Diamonds will cut glass.
 - a. This is a physical property.
 - b. This is a chemical property.

For questions 3-7, determine whether the description is of a physical change or a chemical change.

3. Water can be separated by electrolysis into hydrogen gas and oxygen gas.
 - a. This is a physical change.
 - b. This is a chemical change.
4. Sugar dissolves in water.
 - a. This is a physical change.
 - b. This is a chemical change.
5. Vinegar and baking soda react to produce a gas.
 - a. This is a physical change.
 - b. This is a chemical change.
6. Yeast acts on sugar to form carbon dioxide and ethanol.
 - a. This is a physical change.
 - b. This is a chemical change.
7. Wood burns, producing several new substances.
 - a. This is a physical change.
 - b. This is a chemical change.

References

1. Photo by Magnus Rosendahl. [Melting lakeside](#). Creative Commons Public Domain License
2. PDPphoto.org. [Fireworks](#). Public domain