chapter 15

Classification of Matter

section 2 Properties of Matter

What You'll Learn

- to identify substances using physical properties
- differences between physical and chemical changes
- how to identify chemical changes
- the law of conservation of mass

Before You Read

When you see someone, how do you identify that person as a friend or a stranger? How do you identify a friend on the phone? What are some things about people that help you recognize them? On the lines below, list some things you use to identify people.

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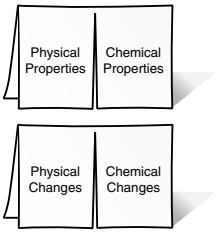
Study Coach

Make Flash Cards For each heading in this section, make a flash card. The flash card should contain the main point of the paragraphs below the heading. When you finish the section, review the flash cards.

FOLDABLES™

B Compare and Contrast Make the following Foldables to help you understand how physical and chemical properties are different, and how physical and chemical changes are different.



Read to Learn

Physical Properties

You can stretch a rubber band, but you can't stretch a piece of string very much. You can bend a piece of wire, but you can't bend a matchstick easily. The rubber band and the wire change shape, but the substances that they are made of do not change.

The ability to stretch or bend is a physical property. A **physical property** is a feature or characteristic that describes an object or substance. Some examples of physical properties are color, shape, size, density, melting point, and boiling point.

How do physical properties describe appearance?

How would you describe a tennis ball? You could describe some of its physical properties, such as shape and color. You could say it is a solid, not a liquid or a gas. For example, you might describe a tennis ball as a brightly colored, hollow sphere. You could also measure some physical properties of the ball. You could measure its diameter with a tape measure. You could measure its mass with a balance. You could measure how high it will bounce.

To describe a soft drink in a cup, you could start by saying it is a brown liquid. You could measure the volume and the temperature of the soft drink. Each of these characteristics is a physical property of that soft drink.

How do physical properties describe behavior?

Some physical properties describe the behavior of a material or substance. You recall that a magnet attracts objects that contain iron, such as a safety pin. Attraction to a magnet is a physical property of iron. Every substance has physical properties that make it useful for certain tasks.

Some metals, such as copper, are useful because they bend easily and can be pulled into wires. Other metals, such as gold, are useful because they easily can be pounded into sheets as thin as 0.1 micrometers. This property of gold makes it useful for decorating picture frames and other things. Flattened gold is called gold leaf.

Think again about the soft drink. If you knock over the cup, the drink will spill. If you knock over a jar of honey, however, it does not flow as quickly. The ability to flow is a physical property of liquids.

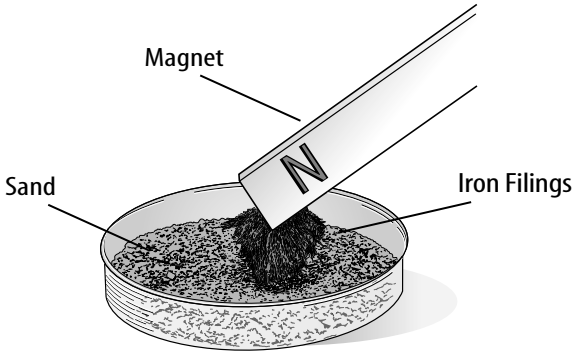
Reading Check

1. **Explain** Why does honey flow more slowly than water?

How are physical properties used to separate materials?

You can use the physical properties of size and hardness to separate some substances. Removing the seeds from a watermelon is easy. The seeds are small and hard, and the flesh of the large watermelon is soft and juicy.

Using Magnetism The dish in the figure below contains sand mixed with iron filings. You probably would not be able to sift out the iron filings. They are about the same size as the sand particles. However, if you pass a magnet through the mixture, it will attract only the iron filings. A magnet does not attract sand. This is an example of using the physical property of magnetism to separate substances in a mixture.



Picture This

2. **Observe** Why would it be difficult to sift the iron filings from the sand?

Physical Changes

When you break a stick of chewing gum, you change its size and shape. You do not change the identity of the materials that make up the gum. A physical change does not change identity.

Why doesn't the identity change?

When a substance freezes, boils, evaporates, or condenses, it undergoes a physical change. A **physical change** is a change in size, shape, or state of matter. Heat might be added or removed during a physical change. Changes in energy do not change the identity of the substance being heated or cooled. All substances have distinct properties that are constant, or never change. The properties of density, specific heat, boiling point, and melting point are constant for substances. These properties can be used to identify unknown substances in a mixture.

Iron is a substance that changes states when it absorbs or releases energy. At high temperatures, iron melts. However, iron has the same physical properties that identify it as iron, whether it is in the liquid or solid state.

Reading Check

3. **Define** What effect does an energy change have on the identity of a substance?

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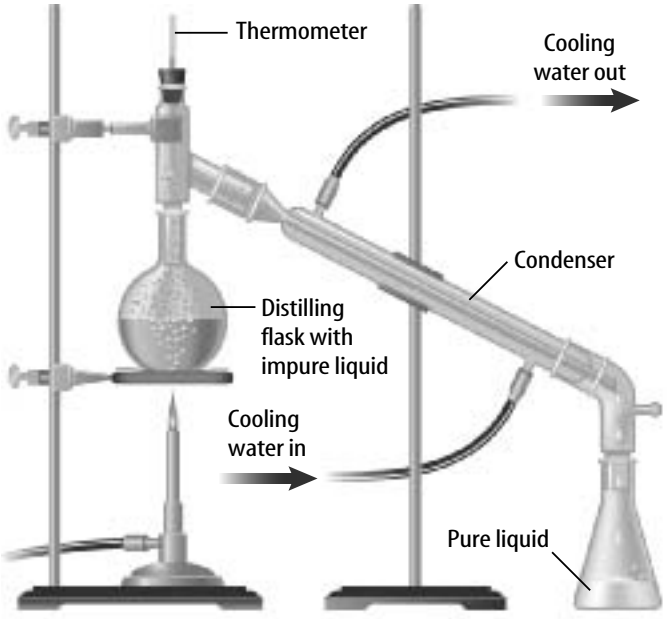
What is distillation?

Distillation is the process of separating substances in a mixture by evaporating a liquid and condensing its vapor. A laboratory distillation process is shown below.

To distill a liquid, it is heated until it vaporizes. Then, the vapors are cooled until they condense. All solid material is left behind. Distillation is used to make drinking water out of salt water.

Liquids with different boiling points can be separated by distilling. The mixture is heated slowly until it begins to boil. Vapors of the liquid with the lowest boiling point form first. They are condensed and collected. As temperature increases, the second liquid boils. Its vapors are condensed and collected. Distillation is used often in industry. Natural oils such as mint are distilled.



Picture This

4. **Observe** Where would you expect to find the solid material left behind in the distillation process?

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Chemical Properties and Changes

A **chemical property** is a characteristic of a substance that indicates whether it can undergo a change that results in a new substance. A warning on a can of liquid paint thinner or lighter fluid states that the liquid is flammable (FLA muh buhl). If a substance is flammable, it can burn. When a substance burns, it produces new substances during a chemical change. Therefore, whether or not a substance is flammable is a chemical property. Knowing which substances are flammable helps you to use them safely.

Another chemical property is how compounds react to light. Some medicines are kept in dark bottles because the compounds will change chemically in the light.

Detecting Chemical Change

Your senses tell you when a chemical change has happened. Leave a pot of chili cooking on the stove too long and you will smell it burning. The smell tells you a new substance formed.

How does the identity of a substance change?

You smell a rotten egg or see rust on a bike. These are signs that chemical changes have taken place. A **chemical change** is a change of one substance to another. When you drop antacid tablets in a glass of water, they foam up. After a lightning strike the air smells different. These are signs that new substances have been produced. Heat, light, and sound are often signs of a rapid energy release and of a chemical change.

The only proof that a chemical change has taken place is that a new substance is formed. For example, when hydrogen and oxygen combine in a rocket engine, their chemical changes produce heat, light, and sound. But there are no such clues when iron combines with oxygen to form rust. Rust forms slowly. The only clue that iron has changed to a new substance is the presence of rust. Burning and rusting are chemical changes because new substances are formed.

How can a chemical change be used to separate substances?

You can separate substances using a chemical change. One example is cleaning silver. Silver chemically reacts with sulfur compounds in the air to form silver sulfide, or tarnish. A different chemical reaction changes the tarnish back to silver using warm water, baking soda, and aluminum foil.

Think it Over

5. Infer How can knowing a chemical property such as flammability help you to use a product safely?

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Reading Check

6. Explain What is the only proof that a chemical change has taken place?

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Weathering—Chemical or Physical Change?

The forces of nature continuously shape Earth's surface. Rocks split, rivers carve deep canyons, sand dunes shift, and interesting formations develop in caves. These changes are known as weathering. Weathering changes are both physical and chemical changes.

What is physical weathering?

As a stream cuts through rock to form a canyon, small particles of rock are carried downstream. The large rocks and the particles of rock have the same properties. Their properties are not changed, so this weathering is physical.

What is chemical weathering?

Limestone is made up mostly of a chemical called calcium carbonate. Calcium carbonate does not dissolve easily in water. But if the water is even slightly acidic, calcium carbonate reacts. A new substance, calcium hydrogen carbonate, is formed. This substance dissolves in water. This change in limestone is a chemical change. The calcium carbonate changes to calcium hydrogen carbonate in the chemical reaction. Rainwater can dissolve limestone because of this reaction. This chemical change leads to weathering. Chemical changes like this one create caves and the rock formations that are found in them.

Think it Over

7. **Apply** How are shifting sand dunes an example of physical weathering?

The Conservation of Mass

Wood is combustible, which means it can burn. As you have learned, this is a chemical property of wood. Think about a log burning in a fireplace. After you burn a piece of wood, there is nothing left but a small pile of ashes. During the fire, the wood gives off heat, light, and smoke. These changes in the wood are all signs of a chemical reaction.

Where did all the matter in the log go as it burned? At first, you might think that matter was lost as the log burned, since the pile of ashes is so small. The ashes have a smaller mass than the wood you started with. But imagine that you could collect all the smoke and gases that escaped from the log while it burned. If you added this all up, you would find that no mass was actually lost.

Mass is not lost during burning. In the same way, mass is not gained or lost in any chemical change. In other words, matter is not created or destroyed in a chemical change. The **law of conservation of mass** states that the mass of all the substances before a chemical change equals the mass of substances after a chemical change.

Reading Check

8. **Explain** what the law of conservation of mass means.

After You Read

Mini Glossary

chemical change: change of one substance to another

chemical property: characteristic of a substance that indicates whether it can undergo a certain chemical change

distillation: the process of separating substances in a mixture by evaporating a liquid and condensing its vapor

law of conservation of mass: the mass of all substances that are present before a chemical change equals the mass of all the substances that remain after the change

physical change: a change in size, shape, or state of matter

physical property: a feature or characteristic that describes an object or substance

1. Review the terms and their definitions in the Mini Glossary. What is the main difference between a physical change and a chemical change?

2. Complete the table below by giving an example of the property or change.

Physical property	Example:
Chemical property	Example:
Physical change	Example:
Chemical change	Example:
Separation using physical change	Example:
Separation using chemical change	Example:

3. Study Coach Imagine explaining physical and chemical changes to a group of elementary school students. Describe some items around your house to use as examples of physical and chemical changes.

End of Section