

Physical and Chemical Properties

Introduction

A good understanding of material things requires an understanding of the physical and chemical characteristics of matter. Such characteristics are familiar to you, and physical and chemical changes are part of your everyday experience. However, you may not yet have a clear idea of the difference between a physical change and a chemical change. You may not yet know exactly how a chemical change is distinguished from a physical change. The purpose of this experiment is to clarify these important distinctions.

The physical properties of a substance are those properties that can be observed and measured without changing the composition of the substance. Physical properties include odor, color, density, solubility, boiling point, and melting point. Because they depend on there being no change in composition, physical properties can be used to describe and identify substances. A colorless, odorless liquid that freezes at 0°C is probably water, for example.

The chemical properties of a substance are those properties that can only be observed when the substance is undergoing a change in composition. The fact that hydrogen peroxide decomposes to give oxygen gas and water is an example of a chemical property.

In a physical change, only the temperature, size, or physical state of a sample of matter is altered. The melting of ice and the evaporation of gasoline are examples of physical changes. In chemical changes, new substances, of different chemical composition, are produced. Examples of chemical change are the rusting of iron and the burning of wood. Readily observable phenomena frequently accompany chemical changes and are often telltale signs that such changes are taking place. These indicative phenomena include the evolution of gas, the production of a color change, the formation of a solid, and the evolution of heat. A process in which a chemical change takes place is called a chemical reaction.

In chemical changes, the original substances **are consumed and new** substances are produced. Still, the total mass of the products of the reaction will always be equal to the total mass of the reactants. This result has been verified by countless experiments and is now accepted as a scientific law—the law of conservation of mass.

In this experiment, you will examine a variety of substances and describe the physical properties of each. You will then cause changes to take place in certain of the substances. Based on your observations and the results of tests you will conduct, you will decide whether these changes are physical or chemical in nature. You will also demonstrate that mass is conserved in a chemical reaction.

Purpose/Objectives

1. To observe the physical and chemical properties of several substances.
2. To decide whether certain observed changes are physical or chemical.

Procedure

Copy Tables 2-1 and 2-2 into your laboratory notebook. As you perform the experiment, record your data and observations in these tables. Note: Always make as many observations as possible during an experiment. Do not be limited by the categories given in the sample tables. Also record any additional observations.

Part A. The Physical Properties of Matter

1. Obtain seven small sheets of paper. Label each with the name of one of the following substances: magnesium, sulfur, iron, sodium bicarbonate, sodium chloride, and sand. Obtain two pieces of magnesium ribbon and place them on the appropriately labeled sheet of paper. Using a clean scoopula, transfer a pea-sized sample of each of the other substances to the appropriately labeled sheet.

2. Examine each substance carefully. Use the magnifying glass. CAUTION: Never taste any of the substances. Do not touch the substances with your hands. Record your observations of the physical appearance of each substance in Table 2-1.

Table 2-1 Data Table for Part A

Substance	Physical State	Color	Odor	Solubility in Water	Effect of Magnet
S					
Fe					
NaHCO ₃					
NaCl					
C ₁₂ H ₂₂ O ₁₁					
sand					
Mg					

3. Test the effect of a magnet on each substance by passing the magnet under the sheet of paper. Do not dip the magnet directly into the material. Record your observations.

4. Test the solubility of each substance in water by adding a small amount of your pea-sized sample to 3 mL of water in separate small test tubes. Mix each sample well by "flicking" the test tube with your finger. CAUTION: Do not use your finger as a *cork*. *Record your observations. Save the magnesium ribbon, and the solid samples remaining on the labeled sheets of paper, for later use. The liquid contents of the test tubes may be washed into the sink.* Dry the magnesium ribbon and save for later use.

Part B. Causing a Physical or Chemical Change

5. Combine the remaining samples of iron filings and sulfur on a clean piece of paper. CAUTION: Do not inhale sulfur powder and exercise care in mixing so as to avoid getting sulfur into the air. Mix the samples thoroughly using a spatula. Examine the mixture with a magnifying glass. Record your observations in Table 2-2. Move a magnet under the paper below the mixture and examine it again with the magnifying glass. Record your observations. Obtain a sample of FeS (Iron Sulfide), this is iron and sulfur chemically bonded together. Repeat step 5.

Table 2-2 Data Table for Parts B and C	
System	Observations
Fe and S mixture —tested with magnet	
FeS —tested with a magnet	
NaCl and sand mixture —mixed with water —filtered —filtrate allowed to evaporate	
Mg —burned in air	
Mg —reacted with 6M HCl	
Mg combustion product —reacted with 6M HCl	
NaHCO ₃ —reacted with 6M HCl	

6. Combine the remaining samples of sodium chloride and sand on a clean piece of paper. Examine the mixture with a magnifying glass, and test the effect of a magnet. Record your observations.

Transfer the salt/sand mixture to a clean 100-mL beaker. Add 30 mL of tap water and stir the mixture with a glass rod. Record your observations.

Filter the mixture as follows. Fold a piece of filter paper in quarters. Open the paper to form a cone with one thickness of paper on one side and three thicknesses on the other. (See Figure 2-1.) Put the filter paper in a funnel and place the funnel in a ring support attached to a ring stand. (See Figure 2-2.)

Figure 2-1

Figure 2-2

Place a 100-mL beaker below the funnel, and pour the salt/sand/water mixture into the funnel. The liquid that passes through the filter is called the Filtrate. Pour 10 mL of the filtrate into an evaporating dish. Set this dish on a square of wire gauze supported by an iron ring attached to a ring stand. Using a gas burner and keeping your face away from the evaporating liquid, heat the dish gently until the filtrate has completely evaporated. Allow the dish to cool. While the dish is cooling, remove the filter paper from the funnel. Examine both the dry residue in the evaporating dish and the wet residue on the filter paper. Record your observations. Discard the filter paper into the waste basket. The other materials may be washed into the sink.

7. CAUTION: Do not look directly at the burning magnesium. Its flame is very bright and can damage your eyes. Keep burning magnesium at arm's length at all times and do not inhale the fumes that are given off in the combustion process. Place a watch glass on the laboratory bench close to your gas burner. Light the burner. Use crucible tongs to grasp one end of a strip of magnesium ribbon and to hold this strip in the burner flame until the magnesium ignites. Position the magnesium so that the product of the combustion will fall onto the watch glass. **DO NOT PLACE THE BURNING MAGNESIUM ON THE WATCH GLASS.** Compare the appearance of this product with that of the original magnesium ribbon. Record your observations.

8. Put the unburned strip of magnesium into a clean, dry test tube. Using a spatula, transfer the combustion product from the watch glass to a second clean, dry test tube. Place the two test tubes in a rack. Add a few drops of hydrochloric acid (HCL) to each tube. CAUTION: Hydrochloric acid is corrosive. Record your observations. Feel the bottom of each test tube. Record any difference in temperature. Wash the contents of both tubes into the sink and rinse the tubes with water.

9. Transfer the sodium bicarbonate sample to a clean, dry test tube. Carefully add 5 drops of hydrochloric acid, one drop at a time. CAUTION: Hydrochloric acid is corrosive. Touch the bottom of the test tube with your hand. Record your observations. The contents of the tube may be washed into the sink.

Findings/Questions

1. For each change you observed in Parts B and C, indicate whether the change was physical or chemical in nature. Give reasons for your answer.

Part B, step 5. Mixing iron and sulfur (no heating).
Heating iron and sulfur to make FeS

Part B, step 6. Mixing salt, sand, and water.

Part B, step 7. Burning magnesium.

Part B, step 8. Mixing magnesium and the combustion product with hydrochloric acid.

Part B, step 9. Mixing sodium bicarbonate and hydrochloric acid.

Results and Conclusions

1. State in your own words the difference between chemical properties and physical properties. Give an example of each that has not been mentioned in this experiment.

2. State in your own words the difference between a chemical change and a physical change.