

The Law of Definite Composition

Background Information

Many compounds are made of exactly the same elements but have very different physical and chemical properties. For example, carbon dioxide, CO_2 , and carbon monoxide, CO , are both gases consisting of carbon and oxygen. Yet carbon dioxide is a harmless gas found in the body while carbon monoxide is a deadly gas when inhaled in sufficient amounts.

The reason for the difference between these two carbon-oxygen compounds is explained by the Law of Definite Composition. This law states that the masses of the elements in a compound always occur in the same proportion. In other words, a carbon monoxide molecule consists of only one carbon atom and one oxygen atom. A carbon dioxide molecule consists of one carbon atom and two oxygen atoms. The difference in the number of oxygen atoms makes these two compounds very different from each other.

In this investigation, you will compare the physical and chemical properties of water and hydrogen peroxide, both of which consist of hydrogen and oxygen.




Problem

How can two compounds consist of the same elements yet be different from each other?

Materials (per group)

- Graduated cylinder
- Hydrogen peroxide, 3%
- Manganese dioxide
- Water
- Safety goggles
- 2 test tubes
- Test-tube rack
- Matches
- 2 wood splints

Procedure

-  1. Put on your safety goggles. Label one test tube " H_2O " (water) and the other " H_2O_2 " (hydrogen peroxide). Measure 5 mL of each compound and pour it into the appropriate test tube.
-  2. Observe the physical properties of each compound and record your observations in the Data Table.
-  3. Put a small amount of manganese dioxide on the tip of one of the wood splints and add a little to each test tube. *If you see evidence of a chemical reaction occurring*, perform the following step: Light the unused wood splint with a match. Blow out the flame so that the wood is glowing at the edges. Insert the glowing splint into the test tube(s) in which a chemical reaction is occurring. Record your observations in the Data Table.

Observations

DATA TABLE

| Compound | Physical properties | Reaction with manganese dioxide |
|--|---------------------|---------------------------------|
| Water (H_2O) | | |
| Hydrogen peroxide (H_2O_2) | | |

Conclusions

1. How do the physical properties of water and hydrogen peroxide compare?

2. What effect did the manganese dioxide have on each compound?

3. How do the chemical properties of water and hydrogen peroxide compare?

- 4. How do the formulas for the two compounds differ? _____

- 5. State a hypothesis to explain why water and hydrogen peroxide have different chemical properties. _____

Critical Thinking and Application

- 1. The atomic mass number of hydrogen is 1.0. The atomic mass number of oxygen is 16.0.
 - a. What is the proportion by mass of hydrogen to oxygen in water?

 - b. What is the proportion by mass of hydrogen to oxygen in hydrogen peroxide?

- 2. Explain how the Law of Definite Proportions explains the fact that although water and hydrogen peroxide consist of the same elements, they have different properties.

- 3. Look up the atomic mass number of carbon in your periodic table. Mass number of carbon: _____
 - a. What is the proportion by mass of carbon to oxygen in carbon monoxide?

 - b. What is the proportion by mass of carbon to oxygen in carbon dioxide?

- 4. Explain how the Law of Definite Proportions explains the fact that although carbon monoxide and carbon dioxide consist of the same elements, they have different properties.

