Introduction to Chemical Reactions

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CONCEPT 1

Introduction to Chemical Reactions

Lesson Objectives

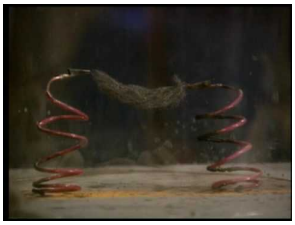
- Describe how chemical reactions occur.
- List signs that a chemical reaction has occurred.

Lesson Vocabulary

- chemical reaction
- equilibrium
- product
- reactant

Introduction

No doubt you've seen changes like those pictured in **Figure** 1.1. What do all these changes have in common? They are all chemical changes in matter. In a chemical change, matter changes into a different substance with different properties. Chemical changes occur because of chemical reactions. You can see more examples of chemical changes at this URL: http://www.youtube.com/watch?v=66kuhJkQCVM (2:05).



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What Is a Chemical Reaction?

A **chemical reaction** is a process in which some substances change into different substances. Substances that start a chemical reaction are called **reactants**. Substances that are produced in the reaction are called **products**. Reactants and products can be elements or compounds. A chemical reaction can be represented by this general equation:

$$\text{Reactants} \rightarrow \text{Products}$$

FIGURE 1.1
Each of these pictures shows a chemical change taking place.

The arrow ($\rightarrow$) shows the direction in which the reaction occurs. The reaction may occur quickly or slowly. For example, foam shoots out of a fire extinguisher as soon as the lever is pressed. But it might take years for metal to rust.

Breaking and Reforming Chemical Bonds

In chemical reactions, bonds break in the reactants and new bonds form in the products. The reactants and products contain the same atoms, but they are rearranged during the reaction. As a result, the atoms are in different combinations in the products than they were in the reactants.

Look at the example in **Figure** 1.2. It shows how water forms. Bonds break in molecules of hydrogen and oxygen. Then new bonds form in molecules of water. In both reactants and products, there are four hydrogen atoms and two oxygen atoms. But the atoms are combined differently in water. You can see another example at this URL: http://www.avogadro.co.uk/h_and_s/bondenthalpy/bondenthalpy.htm.

Reaction Direction and Equilibrium

The arrow in **Figure** 1.2 shows that the reaction goes from left to right, from hydrogen and oxygen to water. The reaction can also go in the reverse direction. If an electric current passes through water, water molecules break down into molecules of hydrogen and oxygen. This reaction would be represented by a right-to-left arrow ($\leftarrow$) in **Figure** 1.2.

Many other reactions can also go in both forward and reverse directions. Often, a point is reached at which the forward and reverse reactions occur at the same rate. When this happens, there is no overall change in the amount of reactants and products. This point is called **equilibrium**, which refers to a balance between any opposing changes. You can see an animation of a chemical reaction reaching equilibrium at this URL: http://www.tutorvista.com/content/chemistry/chemistry-ii/chemical-equilibrium/chemical-equilibrium-animation.php.

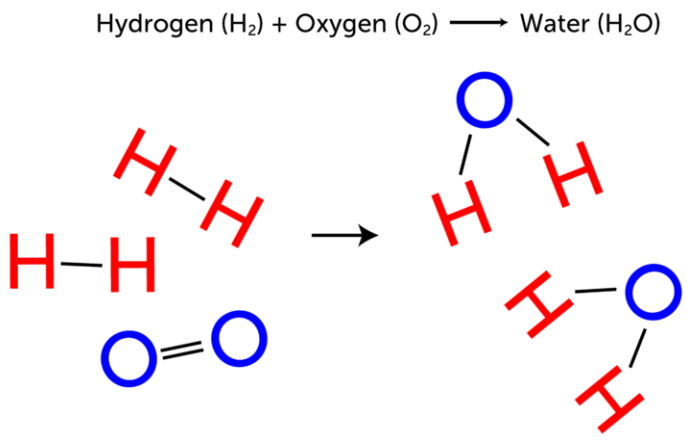


FIGURE 1.2

A chemical reaction changes hydrogen and oxygen to water.

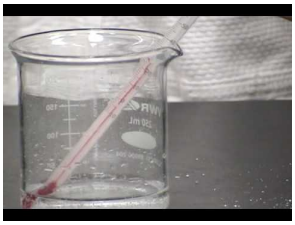
Evidence of Chemical Reactions

Not all changes in matter involve chemical reactions. For example, there are no chemical reactions involved in changes of state. When liquid water freezes or evaporates, it is still water. No bonds are broken and no new products are formed.

How can you tell whether a change in matter involves a chemical reaction? Often, there is evidence. Four common signs that a chemical reaction has occurred are:

- Change in color: the products are a different color than the reactants.
- Change in temperature: heat is released or absorbed during the reaction.
- Production of a gas: gas bubbles are released during the reaction.
- Production of a solid: a solid settles out of a liquid solution. The solid is called a precipitate.

You can see examples of each type of evidence in **Figure** 1.3 and at this URL: http://www.youtube.com/watch?v=gs0j1EZJ1Uc (9:57).



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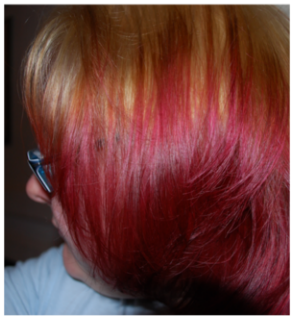
Lesson Summary

- A chemical reaction is a process in which some substances change into different substances. In a chemical reaction, bonds break in reactants and new bonds form in products.
- Evidence that a chemical reaction has occurred include a change in color, a change in temperature, the production of a gas, or the formation of a precipitate.



Change in color
Bleaching hair changes its color.

Change in temperature
Burning wood produces heat.

Production of a gas
Dissolving an antacid tablet in water produces gas bubbles.

Production of a solid
Adding acid to milk produces solid curds of cottage cheese

FIGURE 1.3

Can you think of other examples of changes like these? If so, they probably indicate that a chemical reaction has occurred.

Lesson Review Questions

Recall

1. Define chemical reaction.
2. What are the reactants and products in a chemical reaction?
3. Describe what happens to the atoms involved in a chemical reaction.
4. List four common signs that a chemical reaction has occurred.

Apply Concepts

5. Tina made a "volcano" by pouring vinegar over a "mountain" of baking soda. The wet baking soda bubbled and foamed. Did a chemical reaction occur? How do you know?

Think Critically

6. Explain the meaning of the term "equilibrium" as it applies to a chemical reaction. How can you tell when a chemical reaction has reached equilibrium?

Points to Consider

In **Figure** 1.2, you saw how hydrogen and oxygen combine chemically to form water.

- How could you use chemical symbols and formulas to represent this reaction?
- How many molecules of hydrogen and oxygen are involved in this reaction? How many molecules of water are produced? How could you include these numbers in your representation of the reaction?

References

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