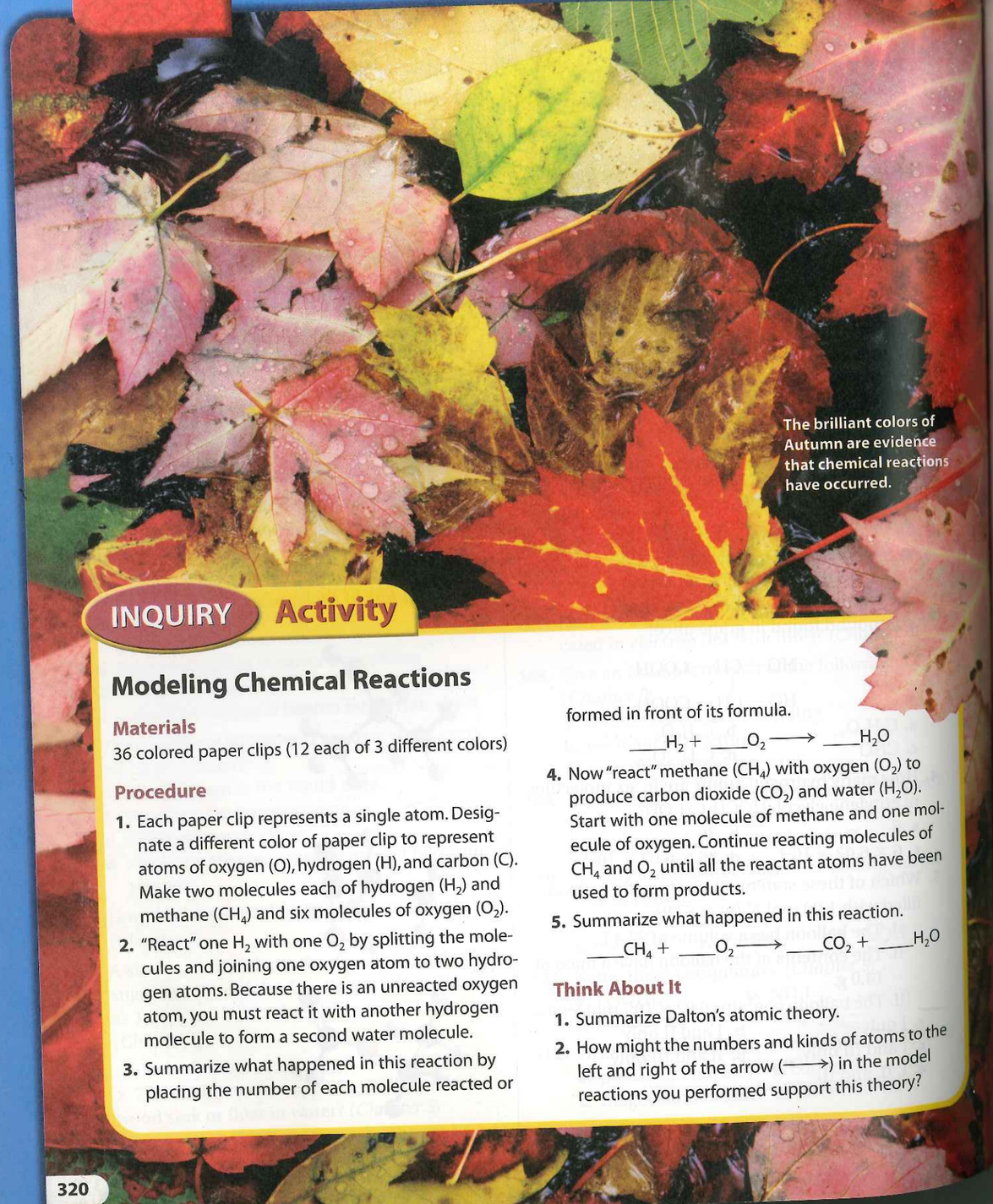
CHAPTER 11

Chemical Reactions



The brilliant colors of Autumn are evidence that chemical reactions have occurred.

INQUIRY Activity

Modeling Chemical Reactions

Materials

36 colored paper clips (12 each of 3 different colors)

Procedure

1. Each paper clip represents a single atom. Designate a different color of paper clip to represent atoms of oxygen (O), hydrogen (H), and carbon (C). Make two molecules each of hydrogen (H_2) and methane (CH_4) and six molecules of oxygen (O_2).
2. "React" one H_2 with one O_2 by splitting the molecules and joining one oxygen atom to two hydrogen atoms. Because there is an unreacted oxygen atom, you must react it with another hydrogen molecule to form a second water molecule.
3. Summarize what happened in this reaction by placing the number of each molecule reacted or formed in front of its formula.

$$\_\_H_2 + \_\_O_2 \longrightarrow \_\_H_2O$$

4. Now "react" methane (CH_4) with oxygen (O_2) to produce carbon dioxide (CO_2) and water (H_2O). Start with one molecule of methane and one molecule of oxygen. Continue reacting molecules of CH_4 and O_2 until all the reactant atoms have been used to form products.
5. Summarize what happened in this reaction.

$$\_\_CH_4 + \_\_O_2 \longrightarrow \_\_CO_2 + \_\_H_2O$$

Think About It

1. Summarize Dalton's atomic theory.
2. How might the numbers and kinds of atoms to the left and right of the arrow (⟶) in the model reactions you performed support this theory?

11.1 Describing Chemical Reactions

Connecting to Your World On May 6, 1937, the huge airship Hindenburg was heading for its landing site in Lakehurst, New Jersey, after an uneventful trans-Atlantic crossing. Suddenly, to the horror of observers on the ground, the airship erupted into a fireball. Within a short time, 210,000 cubic meters of the airship's lifting gas, hydrogen, had burned and the airship was destroyed. The chemical reaction that occurred can be described as "hydrogen combines with oxygen to produce water." In this section, you will learn to represent this chemical reaction by a chemical equation.

Writing Chemical Equations

Every minute of the day chemical reactions take place—both inside you and around you. Not all are as dramatic as the explosion of the Hindenburg, but many are more complex. After a meal, a series of chemical reactions take place as your body digests food. Similarly, plants use sunlight to drive the photosynthetic processes needed to produce plant growth. Although the chemical reactions involved in photosynthesis and digestion are different, both chemical reactions are necessary to sustain life.

In a chemical reaction, one or more substances (the reactants) change into one or more new substances (the products). Figure 11.1a shows the ingredients for making leavened bread—flour, salt, yeast, and water. Chemical reactions take place when the ingredients are mixed together and heated in the oven. Figure 11.1b shows the product—a loaf of bread. Like all chemical reactions, baking bread involves changing substances. Chemists use a chemical equation—a quick, shorthand notation—to convey as much information as possible about what happens in a chemical reaction.

Figure 11.1 Chemical changes occur when bread is baked. **a** Flour, salt, yeast, and water are the ingredients for making leavened bread. **b** Reactants in the ingredients undergo chemical changes to form the product (baked bread). **Observing** ***What evidence shows that chemical changes have occurred?***

Guide for Reading

Key Concepts

- How do you write a word equation?
- How do you write a skeleton equation?
- What are the steps in writing a balanced chemical equation?

Vocabulary

chemical equation
skeleton equation
catalyst
coefficients
balanced equation

Reading Strategy

Relating Text and Visuals As you read this lesson, look carefully at the illustrations of equations. In your notebook, explain how the illustrations demonstrate the difference between a balanced and unbalanced chemical equation.