

## Chapter 5 Reactions

### Conservation of Matter

5. b. *Students know* the idea of atoms explains the conservation of matter: In chemical reactions the number of atoms stays the same no matter how they are arranged, so their total mass stays the same.

### Numbers of Atoms in Chemical Reactions

In a chemical reaction, the total number of reactant atoms is always equal to the total number of product atoms. In other words, atoms do not appear or disappear in a chemical reaction. Instead, the reactant atoms are simply rearranged. This principle, known as the **conservation of matter**, states that during a chemical reaction, matter is neither created nor destroyed. The total number of atoms—hence the total mass—stays the same before and after the reaction.

### Balanced Chemical Equations

A **chemical equation** is a short way to write what is happening during a chemical reaction. Chemical equations use chemical formulas and other symbols. A **chemical formula** is a combination of chemical symbols that represents the elements and their proportions in a molecule. A **chemical symbol** is one or two letters that stand for an element. For example, the symbol C stands for carbon and O stands for oxygen. The chemical formula  $\text{CO}_2$  stands for carbon dioxide. The chemical formula tells you that each molecule of  $\text{CO}_2$  contains one atom of carbon and two atoms of oxygen.

The chemical equation  $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$ , describes the reaction that occurs when calcium carbonate ( $\text{CaCO}_3$ ) breaks down. The reactant, calcium carbonate, is on the left side of the equation. The products, calcium oxide ( $\text{CaO}$ ) and carbon dioxide ( $\text{CO}_2$ ), are on the right. The arrow means “yields.” A plus sign separates two or more reactants and products. This equation is “balanced,” meaning that the number of reactant atoms is equal to the number of product atoms. For example, both the reactants and the products have three atoms of oxygen and one atom of calcium. A balanced equation shows how matter is conserved in a chemical reaction.

Some chemical equations require coefficients to balance the number of reactant and product atoms. A **coefficient** is a number placed in front of a chemical formula in a chemical equation. For a chemical formula without a written coefficient, the coefficient is understood to be 1.

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In the chemical equation  $\text{H}_2 + \text{O}_2 \rightarrow \text{H}_2\text{O}$ , notice that the reactants have two atoms of oxygen, but the product has only one. You cannot use the subscript “2” to balance the number of oxygen atoms because  $\text{H}_2\text{O}_2$  is the chemical formula for a different compound called hydrogen peroxide. To balance the number of oxygen atoms, change the coefficient of water ( $\text{H}_2\text{O}$ ) to 2.

The resulting equation is  $\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$ . Recheck the number of hydrogen and oxygen atoms on both sides of the equation. Is this equation balanced? No, the number of hydrogen atoms is now unequal.

To balance the hydrogen atoms, change the coefficient of hydrogen ( $\text{H}_2$ ) to 2, resulting in the equation  $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$ . Now both the reactants and the products have four atoms of hydrogen and two atoms of oxygen.

### Standard 5. b. Check

**5** In a chemical reaction, the number of reactant atoms

- A is greater than the number of product atoms.
- B is less than the number of product atoms.
- C is equal to the number of product atoms.
- D does not determine the number of product atoms.

**6** According to the principle of the conservation of matter,

- A reactants have the same mass as the products.
- B reactants have more mass than the products.
- C products have less mass than the reactants.
- D products have more mass than the reactants.

**7** How many atoms of oxygen are in a molecule of  $\text{CO}_2$ ?

- A 0
- B 1
- C 2
- D 3

**8**  $\_\_\text{Cu}_2\text{O} + \_\_\text{C} \rightarrow \_\_\text{Cu} + \_\_\text{CO}_2$

Which set of coefficients placed in the blanks above will balance the chemical equation?

- A 1, 1, 2, 2
- B 1, 2, 2, 1
- C 2, 3, 4, 1
- D 2, 1, 4, 1