Section 4.3.
Chemical Equations.

Textbook pages 202 to 215.

Before You Read.

What do you already know about chemical equations?

How are chemical changes and chemical reactions linked?

A chemical change is a change in the arrangements and connections between ions and atoms. Chemical change always involves the conversion of pure substances (elements and compounds) called **reactants** into other pure substances called **products**, which have different properties than the reactants. One or more chemical changes that occur at the same time are called a **chemical reaction**.

How is a chemical reaction represented?

A chemical reaction can be represented using a **chemical equation**. A chemical equation may be written in words (a **word equation**) or in chemical symbols (a **symbolic equation**). In a chemical equation, the reactants are written to the left of an arrow and the products are written to the right. The symbols for **states of matter** may be used to show whether each reactant or product is solid, liquid, gas, or aqueous.

Chemical reactions obey the law of **conservation of mass**. Atoms are neither destroyed nor produced in a chemical reaction. The total mass of the products is always equal to the total mass of the reactants.

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How are chemical equations written and balanced?

Chemical equations are written and balanced through a series of steps, as shown below.

1. Write a word equation: The simplest form of a chemical equation is a word equation. A word equation provides the names of the reactants and products in a chemical reaction. It provides the starting point for writing and balancing chemical equations.

   word equation: methane + oxygen → water + carbon dioxide

2. Write a **skeleton equation**: A **skeleton equation** replaces the names of the reactants and products in a word equation with formulas. However, it does not show the correct proportions in which the reactants will actually combine and the

products will be produced. A skeleton equation is not balanced.

skeleton equation: C.H.4. + O.2. → H.2.O. + C.O.2.

3. Write a balanced equation: A **balanced chemical equation** shows the identities of each pure substance involved in the reaction, as well as the number of atoms of each element on both sides of a chemical equation. Chemical equations are balanced using the lowest whole number **coefficients**. These are integers placed in front of the formula or chemical symbol for each product and reactant. The number of atoms after a chemical reaction is the same as it was before a chemical reaction. You can use this information to determine the coefficients that balance the equation.

   balanced chemical equation: C.H.4. + 2.O.2. → 2.H.2.O. + C.O.2.

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The following strategies can help you translate a word equation into a skeleton equation.

- A chemical symbol is used for nearly all elements when they are not in a compound.
- Three common compounds containing hydrogen that you should memorize are methane, ammonia, and water.

  There are seven common diatomic elements, all of which are non-metals. These are hydrogen, nitrogen, oxygen, fluorine, chlorine, bromine, and iodine. When they occur alone (not in a compound), they are written as H.2., O.2., F.2., B.r.2., I.2., N.2., and C.l.2. You can use the word "HOFBrINCl" to remember them. If an element occurs alone and is not diatomic, no subscript is used. For example, in a chemical equation, oxygen is written as O.2. when it occurs alone, while lead is written as P.b.

The following strategies can help you balance a skeleton equation.

- Balance compounds first and single elements last.
- If you place a coefficient in front of a formula, be sure to balance all the atoms of that formula before moving on.
- Add coefficients only in front of formulas. Do not change subscripts.
- When oxygen or hydrogen appears in more than one formula on the reactant side or the product side of the chemical equation, balance oxygen and hydrogen last.
- You can often treat polyatomic ions as a unit.
- If an equation is balanced by using half a molecule (for example one-half O.2.), you must double all coefficients so that they are all integers.
- When you are finished, perform a final check to be sure that all elements are balanced.