

11

CHEMICAL REACTIONS**SECTION 11.1 DESCRIBING CHEMICAL REACTIONS (pages 321–329)**

This section explains how to write equations describing chemical reactions using appropriate symbols. It also describes how to write balanced chemical equations when given the names or formulas of the reactants and products in a chemical reaction.

► Writing Chemical Equations (pages 321–323)

1. A chemical reaction occurs when one or more _____ change into one or more new substances called _____.
2. The arrow in a reaction means _____
_____.
3. Is the following sentence true or false? When there are two or more reactants or products, they are separated by an arrow. _____
4. Write a word equation that describes the following reactions.
 - a. Acetylene reacts with oxygen to produce carbon dioxide and water.

 - b. When heated, mercury(II) oxide reacts to form mercury and oxygen.

5. What is a chemical equation?

6. A chemical reaction that shows only the formulas, but not the relative amounts of the reactants and products is a(n) _____.
7. Identify the reactant(s) and product(s) in the chemical equation $\text{Li} + \text{Br}_2 \longrightarrow \text{LiBr}$.
 - a. reactant(s) _____
 - b. product(s) _____
8. Circle the letter of each statement that is true about a catalyst.
 - a. A catalyst is the new material produced as a result of a chemical reaction.
 - b. A catalyst is not used up in a chemical reaction.
 - c. A catalyst adds heat to a chemical reaction.
 - d. A catalyst speeds up a chemical reaction.

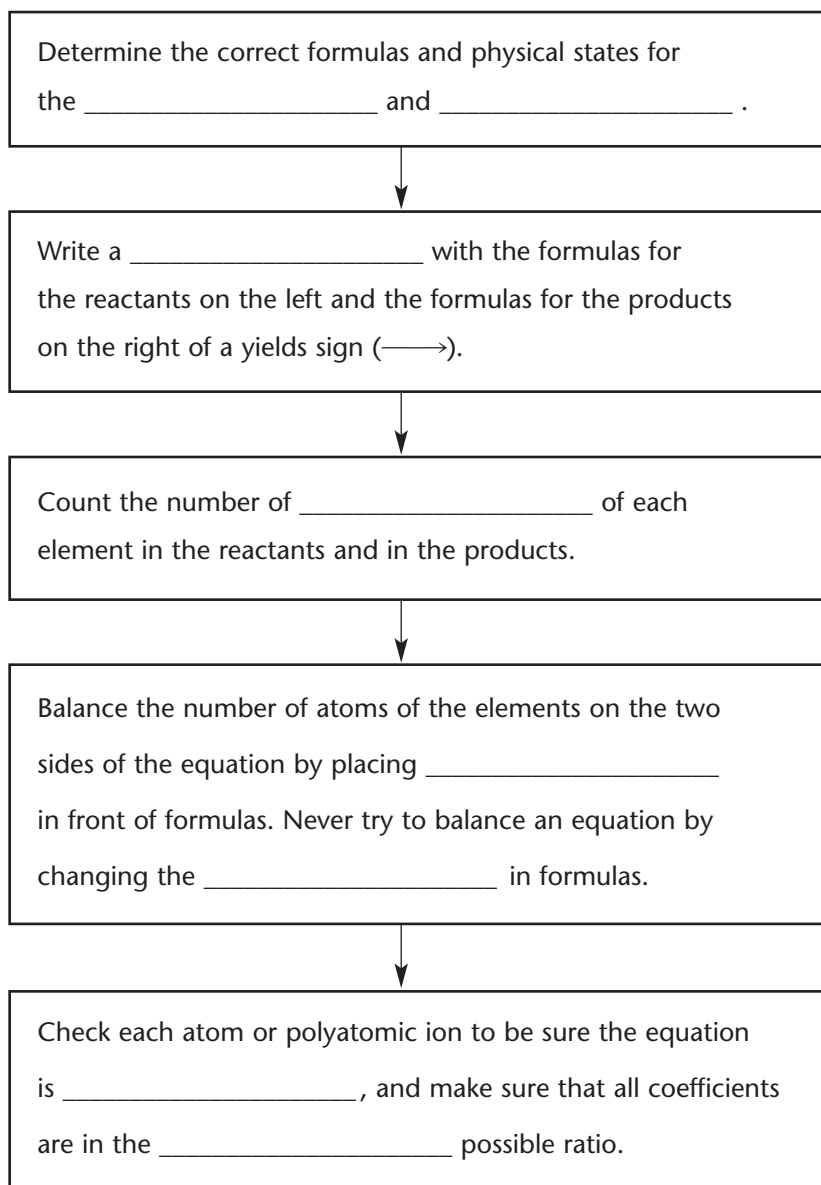
CHAPTER 11, Chemical Reactions (*continued*)

9. Use the symbols in Table 11.1 on page 323 to write a skeleton equation for the following chemical reaction. Hydrochloric acid reacts with zinc to produce aqueous zinc(II) chloride and hydrogen gas.
- _____

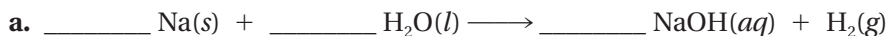
► Balancing Chemical Equations (pages 324–328)

10. What is the law of conservation of mass?
- _____

11. Complete the flowchart for balancing equations.



12. Balance the following chemical equations.

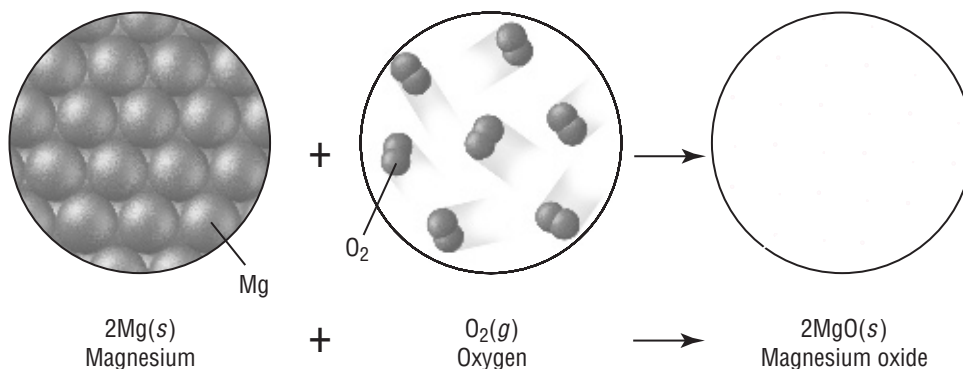


SECTION 11.2 TYPES OF CHEMICAL REACTIONS (pages 330–339)

This section explains how to identify a reaction as a combination, decomposition, single-replacement, double-replacement, or combustion reaction. It also describes how to predict the products of each type of reaction.

► Classifying Reactions (page 330)

- There are _____ general types of chemical reactions.
- Complete the diagram of a combination reaction. Which characteristic of this type of reaction is shown in the diagram?

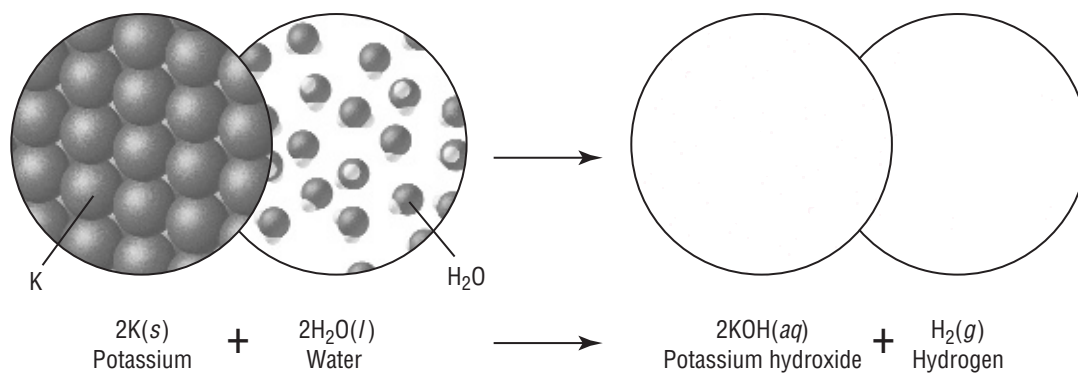


- Is the following sentence true or false? The product of a combination reaction is always a molecular compound. _____
- Circle the letter of each set of reactants that can produce more than one product.

a. two nonmetals	c. a transition metal and a nonmetal
b. a Group A metal and a nonmetal	d. two metals
- Look at Figure 11.6 on page 332. Which characteristics of a decomposition reaction are shown in the diagram?

CHAPTER 11, Chemical Reactions (continued)

- Rapid decomposition reactions can cause _____ as a result of the formation of gaseous products and heat.
- Most decomposition reactions require the addition of _____ in the form of heat, light, or electricity.
- Complete the diagram of a single replacement reaction. Which characteristics of this type of reaction are shown in the diagram?



- Using Table 11.2 on page 333, state whether the following combinations will produce a reaction or no reaction.
 - $\text{Ag}(s) + \text{HCl}(aq)$ _____
 - $\text{Cu}(s) + \text{AgNO}_3(aq)$ _____
- Look at Figure 11.8 on page 335. Which characteristics of a double-replacement reaction are shown in the diagram?

- When solutions of ionic compounds are mixed, what three circumstances may indicate that a double-replacement reaction has occurred?
 - _____
 - _____
 - _____
- Look at the diagram of a combustion reaction in Figure 11.9 on page 336. Which characteristics of this type of reaction are shown in the diagram?

CHAPTER 11, Chemical Reactions (continued)

5. Circle the letter of each sentence that is true about ionic equations.
- A complete ionic equation shows only the ions involved in the reaction.
 - Spectator ions are left out of a net ionic equation.
 - Atoms do not need to be balanced in an ionic equation.
 - Ionic charges must be balanced in a net ionic equation.
6. Write the balanced net ionic equation for this reaction:
 $\text{Pb}(\text{NO}_3)_2(\text{aq}) + \text{KI}(\text{aq}) \longrightarrow \text{PbI}_2(\text{s}) + \text{KNO}_3(\text{aq})$. Show your work.

► Predicting the Formation of a Precipitate (page 344)

7. What determines whether a precipitate forms when two solutions of ionic compounds are mixed?
-
8. Use Table 11.3 on page 344 to predict whether the following compounds are soluble or insoluble.
- $\text{Fe}(\text{OH})_3$ _____
 - NaOH _____
 - $\text{Ca}(\text{ClO}_3)_2$ _____
 - HgSO_4 _____



Reading Skill Practice

A flowchart can help you to remember the order in which events occur. On a separate sheet of paper, create a flowchart that describes the steps for writing a balanced net ionic equation. This process is explained on pages 342–343 of your textbook.

GUIDED PRACTICE PROBLEMS

GUIDED PRACTICE PROBLEM 2 (page 324)

2. Sulfur burns in oxygen to form sulfur dioxide. Write a skeleton equation for this chemical reaction. Include appropriate symbols from table 11.1.

Analyze

Step 1. Identify the relevant concepts.

Write the formula for each reactant and each product. Include the common STP state of each substance.

Reactants

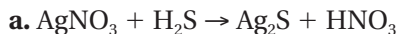
Products

Solve

Step 2. Write the skeleton equation using + between reactants on the left hand side and → to separate reactants from products:

GUIDED PRACTICE PROBLEM 3 (page 327)

3. Balance each equation.
- $\text{AgNO}_3 + \text{H}_2\text{S} \rightarrow \text{Ag}_2\text{S} + \text{HNO}_3$
 - $\text{Zn}(\text{OH})_2 + \text{H}_3\text{PO}_4 \rightarrow \text{Zn}_3(\text{PO}_4)_2 + \text{H}_2\text{O}$



Analyze

Step 1. Identify the relevant concepts.

Count the number of atoms of each element on both sides of the skeleton equation.

Left hand side (lhs):

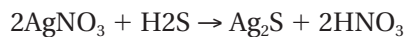
Right hand side (rhs):

CHAPTER 11, Chemical Reactions (continued)

Solve

Step 2. Apply concepts to this situation.

The reactant containing Ag on the lhs needs a multiple of 2, and the product containing H on the rhs needs a multiple of 2. Rewrite the equation with these coefficients and count again.

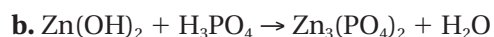


Left hand side (lhs):

Right hand side (rhs):

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Because the number of atoms of each element is the same on both sides, the equation is balanced: _____



Analyze

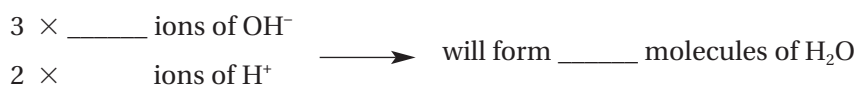
Step 1. Look at the zinc ions on both sides of the equation. Make the number of zinc ions in zinc hydroxide match the number in zinc phosphate.



Step 2. Look at the phosphate ions on both sides of the equation. Make the number of phosphate ions in phosphoric acid match the number of phosphate ions in zinc phosphate.



Step 3. Look at the remaining ions in the reactants—OH⁻ and H⁺.

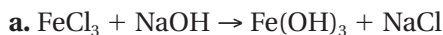
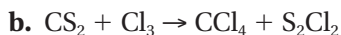
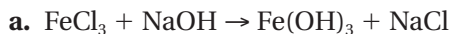


Step 4. Complete the balanced equation.



GUIDED PRACTICE PROBLEM 5 (page 328)

5. Balance each equation.

**Analyze**

Step 1. Identify the relevant concepts.

Count the number of atoms of each element for both sides of the skeleton equation.

Solve

Step 2. Apply concepts to this situation.

The product containing Cl on the rhs needs a multiple of 3, which then means the reactant containing Na on the lhs needs a multiple of 3. Rewrite the equation with these coefficients and count again. This produces a balanced equation.

**Analyze**

Step 1. Identify the relevant concepts.

Count the number of atoms of each element for both sides of the skeleton equation.

Solve

Step 2. Apply concepts to this situation.

The product containing Cl on the lhs needs a multiple of 2 to give a total of six Cl atoms for the rhs. Rewrite the equation with these coefficients and count again. This produces a balanced equation.

GUIDED PRACTICE PROBLEM 13 (page 331)

13. Complete and balance the equation for a combination reaction.

**Analyze**

Step 1. Identify the relevant concepts.

Beryllium is a group 2A metal, which means it will have a 1:1 bond with a group 6A gas, such as oxygen.

CHAPTER 11, Chemical Reactions *(continued)***Solve**

Step 2. Apply concepts to this situation.

The skeleton equation for this combination reaction is: $\text{Be} + \text{O}_2 \rightarrow \text{BeO}$

A coefficient of 2 is needed before the product to balance the number of oxygen atoms. Then a coefficient of 2 is needed before the reactant Be.

The balanced equation is:

GUIDED PRACTICE PROBLEM 15 (page 332)

15. Complete and balance the equation for a decomposition reaction.

$\text{HI} \rightarrow$

Analyze

Step 1. Identify relevant concepts.

Remember that both hydrogen and iodine exist as diatomic molecules.

Solve

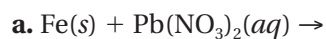
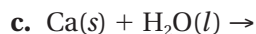
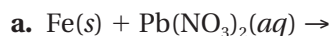
Step 2. Apply concepts to this situation.

The skeleton equation for this decomposition reaction is: $\text{HI} \rightarrow \text{H}_2 + \text{I}_2$

Balancing the equation gives the result.

GUIDED PRACTICE PROBLEM 17 (page 334)

17. Complete the equations for these single-replacement reactions in aqueous solution. Balance each equation. Write “no reaction” if a reaction does not occur. Use the activity series.

**Analyze**

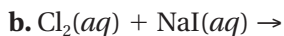
Step 1. Identify relevant concepts.

Table 11.2 shows that iron is more reactive than lead.

Solve

Step 2. Apply concepts to this situation.

Fe replaces Pb. A reaction occurs resulting in the balanced equation:

**Analyze**

Step 1. Identify relevant concepts.

On the periodic table, notice that Cl and I are group 7A halogens and Cl is more reactive than I.

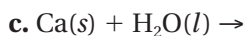
Solve

Step 2. Apply concepts to this situation.

Cl replaces I. Recall that iodine exists as a diatomic molecule. A reaction occurs resulting in the skeleton equation:



Balancing this equation gives this result.

**Analyze**

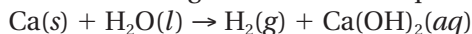
Step 1. Identify relevant concepts.

In Table 11.2, notice that Ca is more reactive than H and can replace H in water as well as in an acid.

Solve

Step 2. Apply concepts to this situation.

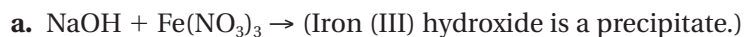
One Ca replaces one H, but notice Ca has a 2+ charge and OH has a 1- charge. Also, hydrogen gas exists as a diatomic molecule. A reaction occurs resulting in the skeleton equation:



Balancing the equation gives this result.

CHAPTER 11, Chemical Reactions (*continued*)**GUIDED PRACTICE PROBLEM 18** (page 335)

18. Write the products of these double-replacement reactions. Balance each equation.

**Analyze**

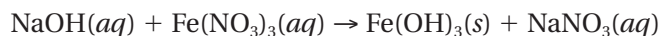
Step 1. Identify relevant concepts.

The driving force is the formation of the precipitate iron (III) hydroxide—
 $\text{Fe}(\text{OH})_3$

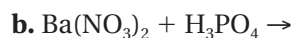
Solve

Step 2. Apply concepts to this situation.

Fe and Na replace each other. A reaction occurs resulting in the skeleton equation:



Balancing this equation gives this result:

**Analyze**

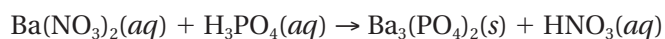
Step 1. Identify relevant concepts.

The driving force is the formation of the precipitate barium phosphate—
 $\text{Ba}_3(\text{PO}_4)_2$

Solve

Step 2. Apply concepts to this situation.

Ba and H replace each other. A reaction occurs resulting in the skeleton equation:



Balancing this equation gives the result:

GUIDED PRACTICE PROBLEM 21 (page 337)

21. Write a balanced equation for the complete combustion of glucose ($C_6H_{12}O_6$).

Analyze

Step 1. Identify the relevant concepts.

Oxygen gas is the other reactant in a combustion reaction. The products are CO_2 and H_2O . Write a skeleton equation for this reaction.

Solve

Step 2. Apply concepts to this situation.

Balance the equation.
