

Types of Chemical Reactions

Textbook pages 256–271

Before You Read

Many chemical reactions occur in daily life. In the lines below, describe one chemical reaction you have observed.

How are chemical reactions classified?

Chemical reactions can be classified as one of six main types: synthesis, decomposition, single replacement, double replacement, neutralization (acid-base), or combustion. You can identify each type of reaction by examining the reactants. This makes it possible to classify a reaction and then predict the identity of the products.

What is a synthesis (combination) reaction?

In a **synthesis** (combination) reaction, two or more reactants (A and B) combine to produce a single product (AB).

element + element → compound

$A + B \rightarrow AB$

(The letters A and B represent elements.)

hydrogen + oxygen → water ✓

What is a decomposition reaction?

In a **decomposition** reaction a compound is broken down into smaller compounds or separate elements. A decomposition reaction is the reverse of a synthesis reaction.

compound → element + element

$AB \rightarrow A + B$

calcium chlorate → calcium chloride + oxygen



Make Flash Cards

Create flash cards to help you learn the different reactions. Write the name of the reaction on the front of the card and an example on the back.



Reading Check

How many products are there in a synthesis reaction?

What is a single replacement reaction?

In a **single replacement** reaction, a reactive element (a metal or a non-metal) and a compound react to produce another element and another compound. In other words, one of the elements in the compound is replaced by another element. The element that is replaced could be a metal or a non-metal.

element + compound \rightarrow element + compound

$A + BC \rightarrow B + AC$ where A is a metal OR

$A + BC \rightarrow C + BA$ where A is a non-metal

aluminum + lead(II) nitrate \rightarrow aluminum nitrate + lead

What is a double replacement reaction?

A **double replacement** reaction usually involves two ionic solutions that react to produce two other ionic compounds. One of the compounds forms a **precipitate**, which is an insoluble solid that forms from a solution. The precipitate floats in the solution, then settles and sinks to the bottom. The other compound may also form a precipitate, or it may remain dissolved in solution.

ionic solution + ionic solution \rightarrow ionic solution + ionic solid

$AB(aq) + CD(aq) \rightarrow AD(aq) + CB(s)$

iron(II) chloride + lithium phosphate
 \rightarrow iron(II) phosphate + lithium chloride

What is a neutralization (acid-base) reaction?

When an acid and a base are combined, they will neutralize each other. In a neutralization (acid-base) reaction, an acid and a base react to form a salt and water.

acid + base \rightarrow salt + water

$HX + MOH \rightarrow MX + H_2O$

(X represents a negative ion. M represents a positive ion.)

sulphuric acid + sodium hydroxide
 \rightarrow sodium sulphate + water ✓

**Reading Check**

What is another name for a neutralization reaction?

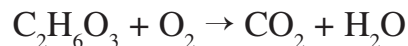
What is a combustion reaction?

Combustion is the rapid reaction of a compound or element with oxygen to form an oxide and produce heat. For example, organic compounds, such as methane, combust with oxygen to form carbon dioxide (the oxide of carbon) and water (the oxide of hydrogen).

hydrocarbon + oxygen \rightarrow carbon dioxide + water



(The subscripts X and Y represent integers.)



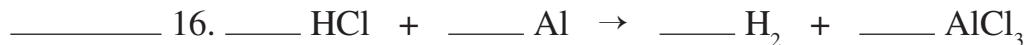
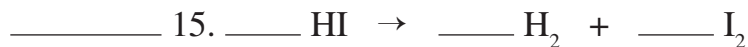
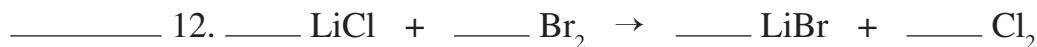
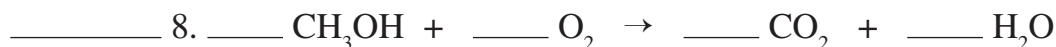
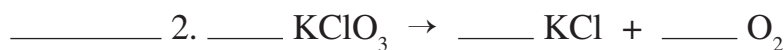
The summary chart below compares the six types of chemical reactions.

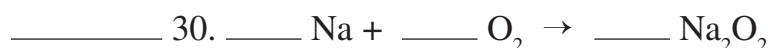
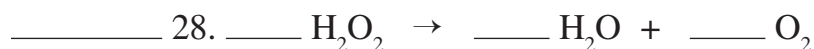
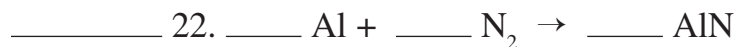
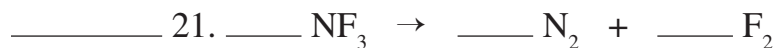
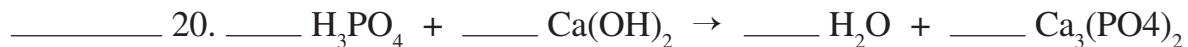
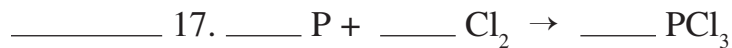
Reaction Type	Reactants and Products	Notes on the Reactants
Synthesis (combination)	$A + B \rightarrow AB$	• Two elements combine
Decomposition	$AB \rightarrow A + B$	• One reactant only
Single replacement		
If A is a metal	$A + BC \rightarrow B + AC$	• One element and one compound
If A is a non-metal	$A + BC \rightarrow C + BA$	
Double replacement	$AB + CD \rightarrow AD + CB$	• Two compounds react.
Neutralization (acid-base)	$HX + MOH \rightarrow MX + H_2O$	• Acid plus base
Combustion	$C_X H_Y + O_2 \rightarrow CO_2 + H_2O$	• Organic compound with oxygen

Use with textbook pages 256–267.

Classifying chemical reactions

Classify each of the following reactions as synthesis (S), decomposition (D), single replacement (SR), double replacement (DR), neutralization (N), or combustion (C). Place the correct letter representing the reaction type in the space provided. Then **balance** the chemical equation by placing the correct coefficients in the equation.





Use with textbook pages 256–267.

Types of chemical reactions—Word equations

Classify each of the following chemical reactions as synthesis (S), decomposition (D), single replacement (SR), double replacement (DR), or neutralization (N). Then **write a balanced equation** for each word equation.

_____ 1. magnesium + sulphur \rightarrow magnesium sulphide

_____ 2. potassium hydroxide + sulphuric acid \rightarrow water + potassium sulphate

_____ 3. chlorine + potassium iodide \rightarrow potassium chloride + iodide

_____ 4. aluminum chloride + sodium hydroxide \rightarrow aluminum hydroxide + sodium chloride

_____ 5. lead(II) oxide \rightarrow lead + oxygen

_____ 6. magnesium + silver nitrate \rightarrow silver + magnesium nitrate

_____ 7. cadmium(II) nitrate + ammonium sulphide \rightarrow cadmium(II) sulphide + ammonium nitrate

_____ 8. tin(IV) hydroxide + hydrogen bromide \rightarrow water + tin(IV) bromide

_____ 9. sodium + oxygen \rightarrow sodium oxide

_____ 10. sodium nitride \rightarrow sodium + nitrogen

Name _____

Date _____

_____ 11. calcium hydroxide + phosphoric acid \rightarrow water + calcium phosphate

_____ 12. barium chloride + sodium carbonate \rightarrow barium carbonate + sodium chloride

_____ 13. zinc + nickel(II) nitrate \rightarrow zinc nitrate + nickel

_____ 14. antimony + iodine \rightarrow antimony(III) iodide

_____ 15. carbon dioxide \rightarrow carbon + oxygen

_____ 16. iron(III) sulphate + lead \rightarrow lead(II) sulphate + iron

_____ 17. barium nitrate + ammonium carbonate \rightarrow ammonium nitrate + barium carbonate

_____ 18. zinc hydroxide + hydrochloric acid \rightarrow water + zinc chloride

_____ 19. ammonium carbonate + magnesium chloride \rightarrow ammonium chloride + magnesium carbonate

_____ 20. rubidium hydroxide + sulphuric acid \rightarrow water + rubidium sulphate

Use with textbook pages 256–267.

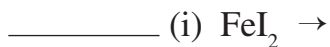
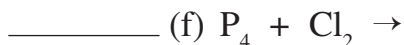
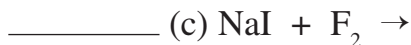
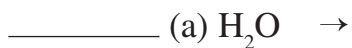
Predicting the products

1. For each of the following:

I. predict the products

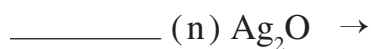
II. classify the reaction as synthesis (S), decomposition (D), single replacement (SR), double replacement (DR), neutralization (N), or combustion (C)

III. write a balanced equation



Name _____

Date _____



2. For each of the following:

I. complete the word equation by predicting the products

II. classify the reaction as synthesis (S), decomposition (D), single replacement (SR), double replacement (DR), or neutralization (N)

III. write a balanced equation for each word equation



Use with textbook pages 256–267.

Types of chemical reactions

Match each Chemical Equation to a Reaction Type below. Each Reaction Type may be used only once.

Chemical Equation

- _____ $2 \text{KClO}_3 \rightarrow 2 \text{KCl} + 3 \text{O}_2$
- _____ $16 \text{Al} + 3 \text{S}_8 \rightarrow 8 \text{Al}_2\text{S}_3$
- _____ $\text{LiOH} + \text{HNO}_3 \rightarrow \text{H}_2\text{O} + \text{LiNO}_3$
- _____ $2 \text{C}_6\text{H}_{14} + 19 \text{O}_2 \rightarrow 14 \text{H}_2\text{O} + 12 \text{CO}_2$
- _____ $2 \text{AgNO}_3 + \text{Cu} \rightarrow \text{Cu}(\text{NO}_3)_2 + 2 \text{Ag}$
- _____ $\text{Pb}(\text{NO}_3)_2 + \text{K}_2\text{CrO}_4 \rightarrow \text{PbCrO}_4 + 2 \text{KNO}_3$

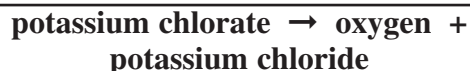
Reaction Type

- synthesis
- combustion
- neutralization
- decomposition
- single replacement
- double replacement

- What type of chemical reaction involves two smaller molecules reacting to produce one larger molecule?
 - synthesis
 - combustion
 - decomposition
 - single replacement
- Carbon dioxide gas can be broken down into solid carbon and oxygen gas. What type of reaction is this?

A. synthesis	C. neutralization
B. combustion	D. decomposition

Use the following word equation to answer question 9.



- What type of reaction is represented by the word equation?
 - synthesis
 - decomposition
 - single replacement
 - double replacement
- Which of the following represents a single replacement reaction?

I.	$\text{Sn} + 2 \text{AgNO}_3 \rightarrow \text{Sn}(\text{NO}_3)_2 + 2 \text{Ag}$
II.	gold(II) cyanide + zinc \rightarrow gold + zinc cyanide
III.	Magnesium iodide reacts with bromine gas to produce magnesium bromide and iodine.

- | | |
|--------------------------|---------------------------|
| A. I and II only | C. II and III only |
| B. I and III only | D. I, II, and III |
- Which set of ordered coefficients balances the following equation?

$$\text{Fe} + \text{O}_2 \rightarrow \text{Fe}_2\text{O}_3$$

A. 2, 1, 1	C. 4, 2, 3
B. 2, 2, 2	D. 4, 3, 2
 - What coefficient is needed for water in order to balance the following equation?

$$\text{C}_2\text{H}_6 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$$

A. 2	C. 4
B. 3	D. 6
 - Hydrochloric acid can be used to neutralize barium hydroxide. What is the formula for the salt produced by this neutralization?

A. BaCl_2	C. $\text{Ba}(\text{ClO}_2)_2$
B. $\text{Ba}(\text{ClO})_2$	D. $\text{Ba}(\text{ClO}_3)_2$

14. Which reactants form the salt MgSO_4 in a neutralization reaction?

- A. SO_2 and MgO_2
- B. H_2S and MgOH
- C. H_2O and $\text{Mg}(\text{OH})_2$
- D. H_2SO_4 and $\text{Mg}(\text{OH})_2$

15. Given the incomplete equation of a chemical reaction: $\text{C}_9\text{H}_6\text{O}_4 + \text{O}_2 \rightarrow$

Which of the following are the products formed from this reaction?

I.	H_2
II.	H_2O
III.	CO_2

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II, and III

16. Given the incomplete equation of a chemical reaction:

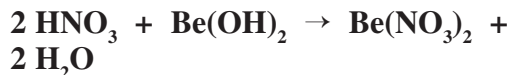
barium chloride + ammonium carbonate \rightarrow

Which of the following are the products formed from this reaction?

I.	H_2O
II.	NH_4Cl
III.	BaCO_3

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II, and III

Use the following chemical reaction to answer question 17.



17. Which of the following statements is true?

I.	HNO_3 is an acid.
II.	$\text{Be}(\text{NO}_3)_2$ is a base.
III.	This is a neutralization reaction.
IV.	The products of this reaction are a salt and water.

- A. I, II, and III only
- B. I, II, and IV only
- C. I, III, and IV only
- D. II, III, and IV only

18. Sodium nitrate is produced as a result of mixing a solution of cadmium(II) nitrate with a solution of sodium sulphide. What is the other compound formed from this reaction?

- A. CdS
- B. CdSO_4
- C. NaS_2
- D. CdNO_4