

Textbook pages 140–157

What happens during a chemical reaction, and how can it be described?

Before You Read

Describe a chemical reaction that you have seen today. How did you know this was a chemical reaction?

During a chemical reaction, chemical compounds are changed into different compounds with different properties.

The products of a chemical reaction are always new substances with new properties compared to the reactants. There are several clues that a chemical reaction has taken place.

- There is a change in energy.
- There is a change in colour.
- A gas is formed.
- A solid substance (a precipitate) is formed. ✓

The four types of chemical reactions can be described using word equations.

name of reactant **name of reactant** **name of product** **name of product**
1 and **2** react to produce **3** and **4**

means

name of reactant **name of reactant** **name of product** **name of product**
1 + **2** → **3** + **4**

There are four main types of chemical reactions.

Type of reaction	Representation of the reaction	Example
Synthesis reaction • Two or more reactants combine to produce a new product.	$A + B \rightarrow AB$ 	zinc + sulfur $\rightarrow$ zinc sulfide.
Decomposition reaction • One compound breaks down into two or more simpler compounds or elements.	$AB \rightarrow A + B$ 	calcium chlorate $\rightarrow$ calcium + chlorate
Single displacement reaction • One element takes the place of another element in a compound.	$A + BC \rightarrow AC + B$ $D + BC \rightarrow BD + C$ 	aluminum + hydrogen chloride $\rightarrow$ aluminum chloride + hydrogen chloride + sodium iodide $\rightarrow$ sodium chloride + iodine
Double displacement reaction • The metal ions of two different compounds exchange places.	$AB + CD \rightarrow AD + CB$ 	barium nitride + magnesium sulfide $\rightarrow$ barium sulfide + magnesium nitride

Reading Check

1. List three clues that will tell you a chemical reaction has occurred.

2. What type of reaction is hydrogen + oxygen $\rightarrow$ water?

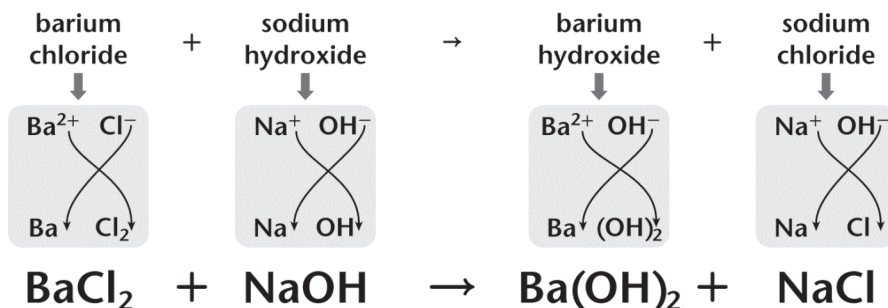


Elements That Contain More Than One Atom of the Element

Non-metal element	Found in nature as
hydrogen, H	H ₂
nitrogen, N	N ₂
oxygen, O	O ₂
fluorine, F	F ₂
phosphorus, P	P ₄
sulfur, S	S ₈
chlorine, Cl	Cl ₂
selenium, S	Se ₈
bromine, Br	Br ₂
iodine, I	I ₂

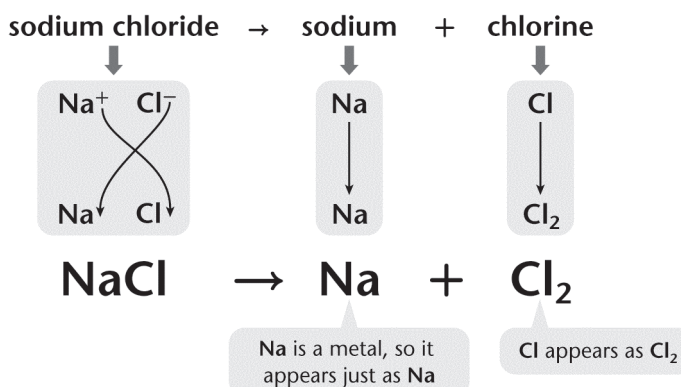
Chemical reactions can be described using chemical equations.

To write a **chemical equation**, you start with a word equation. Then use the rules that you have learned to translate each chemical name into the correct chemical formula.



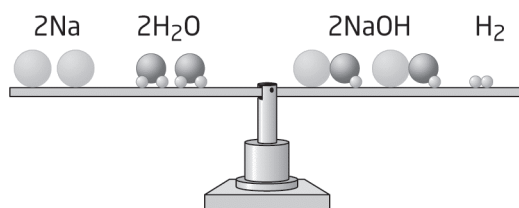
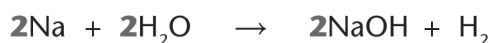
Note that compounds containing more than one OH ion (hydroxide ion) have brackets around the OH.

If there is an element name in the word equation, the chemical symbol for most of the elements can be found on the periodic table. There are a few non-metal elements that contain more than one atom of the element in their chemical symbol. The list in the margin shows you the symbols for these elements.



Atoms and mass are conserved during a chemical reaction.

During a chemical reaction, atoms are not created and they are not destroyed. The atoms of the reactants are rearranged to make new products. This is the **law of conservation of mass** and why **chemical reactions must be balanced**. The number of atoms of each element on the reactant side of the equation must be the same as the number of atoms of each element on the product side. ✓



Balance an Equation

1. Make a table of reactants and products. Count how many of each type of atom are on each side of the equation.

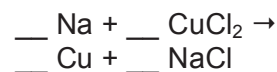
2. Find an unbalanced atom. Multiply the compound on the other side of the equation, which has that atom, by a number to balance this atom in the reaction. Change the numbers in your table to show the change.

3. Repeat step 2 for any other unbalanced atoms, until all the atoms are balanced.

4. Count the atoms on each side of the equation to make sure that they are all balanced.

✓ Reading Check

3. Balance the following equation.



Use with textbook pages 142 to 145.

Chemical reactions and chemical compounds

Vocabulary

a gas forms
a precipitate forms
and
balanced
chemical formulas
colour change

decomposition
double displacement
heat produced
light produced
products
react to produce

reactants
single displacement
synthesis
word equation

Use the terms in the vocabulary box to fill in the blanks. You can use each term more than once. You will not need to use every term. Some questions have more than one correct answer.

1. A reaction in which a metal element displaces the metal atom of a compound is a _____ reaction.
2. In a reaction, the “→” means _____ while the “+” means _____.
3. A _____ uses words to describe what happens to reactants and products during a chemical reaction.
4. In order to make sure the number of atoms in the reactants is equal to the number of atoms in the products, chemical reactions must be _____.
5. Two clues that a chemical reaction has occurred are _____ and _____.
6. The beginning substances in a chemical reaction are the _____ while the ending substances are the _____.
7. The chemical reaction $\text{Ag} + \text{O}_2 \rightarrow \text{Ag}_2\text{O}$ is a _____ reaction.
8. A reaction in which one reactant breaks into two smaller products is a _____ reaction.
9. In order to understand chemical equations around the world, _____ are used instead of word equations because they mean the same thing in every country.

Use with textbook pages 144 to 145.

Classifying chemical equations

Classify each of the following reactions as a synthesis (S), decomposition (D), single displacement (SD), or double displacement (DD).

- _____ 1. copper chloride + zinc $\rightarrow$ zinc chloride + copper
- _____ 2. magnesium + oxygen $\rightarrow$ magnesium oxide
- _____ 3. aluminum fluoride + bromine $\rightarrow$ aluminum bromide + fluorine
- _____ 4. lead nitrate + potassium iodide $\rightarrow$ lead iodide + potassium nitrate
- _____ 5. nickel sulfide $\rightarrow$ nickel + sulfur
- _____ 6. lead + bromine $\rightarrow$ lead bromide
- _____ 7. sodium sulfide + barium hydroxide $\rightarrow$ sodium hydroxide + barium sulfide
- _____ 8. tin iodide $\rightarrow$ tin + iodine
- _____ 9. $\text{Ni I}_2 + \text{F}_2 \rightarrow \text{NiF}_2 + \text{I}_2$
- _____ 10. $\text{K} + \text{HOH} \rightarrow \text{KOH} + \text{H}_2$
- _____ 11. $\text{Cu} + \text{AgNO}_3 \rightarrow \text{Cu(NO}_3)_2 + \text{Ag}$
- _____ 12. $\text{HgO} \rightarrow \text{Hg} + \text{O}_2$
- _____ 13. $\text{Ba} + \text{Cl}_2 \rightarrow \text{BaCl}_2$
- _____ 14. $\text{H}_2\text{S} + \text{LiOH} \rightarrow \text{Li}_2\text{S} + \text{HOH}$
- _____ 15. $\text{CoBr}_2 + \text{Pb(NO}_3)_2 \rightarrow \text{bBr}_2 + \text{Co(NO}_3)_2$
- _____ 16. $\text{Ba} + \text{P}_4 \rightarrow \text{Ba}_3\text{P}_2$

Use with textbook pages 145 to 147.

Word equations into chemical equations

Classify each chemical reaction as a synthesis (S), decomposition (D), single displacement (SD), or double displacement (DD). Then express the word equation as a chemical equation.

_____ 1. magnesium + sulfur → magnesium sulfide

_____ 2. sodium hydroxide → sodium oxide + water

_____ 3. calcium sulfide + hydrogen chloride → calcium chloride + hydrogen sulfide

_____ 4. chlorine + strontium iodide → strontium chloride + iodine

_____ 5. silver oxide → silver + oxygen

_____ 6. calcium hydroxide + hydrogen nitride → hydrogen hydroxide + calcium nitride

_____ 7. lithium + silver fluoride → lithium fluoride + silver

_____ 8. aluminum chloride + sodium bromide → sodium chloride + aluminum bromide

_____ 9. zinc + magnesium phosphide → magnesium + zinc phosphide

_____ 10. sodium + oxygen → sodium oxide

Use with textbook pages 148 to 151.

Balancing chemical equations

Refer to page 149 for detailed instructions on how to balance chemical equations.

Balance each chemical equation by inserting the correct coefficients, or numbers.

1. _____ Ni_3 $\rightarrow$ _____ N_2 + _____ I_2
2. _____ Fe_2O_3 + _____ HCl $\rightarrow$ _____ FeCl_3 + _____ H_2O
3. _____ Zn + _____ Cu_3N_2 $\rightarrow$ _____ Cu + _____ Zn_3N_2
4. _____ PbCl_2 + _____ NaI $\rightarrow$ _____ PbI_2 + _____ NaCl
5. _____ H_2S + _____ Al $\rightarrow$ _____ H_2 + _____ Al_2S_3
6. _____ As + _____ O_2 $\rightarrow$ _____ As_2O_5
7. _____ Al + _____ I_2 $\rightarrow$ _____ AlI_3
8. _____ HgO $\rightarrow$ _____ Hg + _____ O_2
9. _____ Ba + _____ HOH $\rightarrow$ _____ H_2 + _____ Ba(OH)_2
10. _____ K + _____ Br_2 $\rightarrow$ _____ KBr
11. _____ SiO_2 + _____ HF $\rightarrow$ _____ SiF_4 + _____ H_2O
12. _____ S + _____ O_2 $\rightarrow$ _____ SO_3
13. _____ Cl_2 + _____ FeBr_3 $\rightarrow$ _____ FeCl_3 + _____ Br_2
14. _____ H_2 + _____ F_2 $\rightarrow$ _____ HF
15. _____ Li + _____ H_2O $\rightarrow$ _____ LiOH + _____ H_2
16. _____ CuI_2 + _____ Fe $\rightarrow$ _____ FeI_2 + _____ Cu
17. _____ BN + _____ F_2 $\rightarrow$ _____ BF_3 + _____ N_2
18. _____ FeCl_3 + _____ Ca(OH)_2 $\rightarrow$ _____ Fe(OH)_3 + _____ CaCl_2

Use with textbook pages 146–152.

Chemical reactions and chemical equations

Rewrite the each sentence as a **chemical word equation**. Then write the chemical equation for the reaction by first writing the **chemical formula** for each reactant and product, and then **balance the chemical equation**.

1. When aluminum metal is exposed to oxygen, aluminum oxide is formed.

word equation: _____

chemical equation: _____

2. Water reacts with sodium oxide powder to produce a sodium hydroxide solution.

word equation: _____

chemical equation: _____

3. Hydrogen gas reacts with nitrogen trifluoride gas to form nitrogen gas and hydrogen fluoride.

word equation: _____

chemical equation: _____

4. When heated vigorously, mercury oxide breaks down into liquid mercury and oxygen gas.

word equation: _____

chemical equation: _____

5. When solid phosphorus is burned in oxygen, phosphorus trioxide is formed.

word equation: _____

chemical equation: _____

6. Copper sulfide decomposes into copper and sulfur when heated in a very hot flame.

word equation: _____

chemical equation: _____

Name _____

Date _____

7. Chlorine and sodium iodide react to form sodium chloride and iodine.

word equation: _____

chemical equation: _____

8. When silver chloride is mixed with sodium sulfide, sodium chloride and silver sulfide are formed.

word equation: _____

chemical equation: _____

9. When grey zinc powder and yellow sulfur powder are mixed and then heated, a white solid called zinc sulfide is formed.

word equation: _____

chemical equation: _____

10. Hydrogen chloride mixes with sodium hydroxide forming sodium chloride and water (hydrogen hydroxide).

word equation: _____

chemical equation: _____

Use with textbook pages 140 to 157.

What happens during a chemical reaction, and how can it be described?

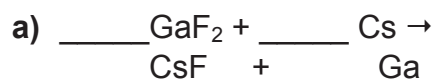
Match each Term on the left with the best Descriptor on the right. Each Descriptor may be used only once.

Term	Descriptor
1. _____ law of conservation of mass	A. a representation of a chemical reaction using words.
2. _____ double displacement reaction	B. a reaction in which the metal atoms of two compounds "switch."
3. _____ synthesis reaction	C. a chemical reaction, in which the total mass and number of atoms of the reactants equal the total mass and number of atoms of the products.
4. _____ chemical equation	D. a reaction in which two elements combine to form a compound.
5. _____ word equation	E. a representation of a chemical reaction using formulas.

6. Write the chemical equation for the given word equation.

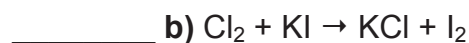
carbon + oxygen → carbon dioxide

7. Balance the chemical equations.



8. Label each reaction as synthesis (S), decomposition (D), single displacement (SD), or double displacement (DD).

_____ a) sodium nitride → sodium + nitrogen



9. What types of reactions are shown? Write the balanced chemical equations.

_____ a) phosphorus + chlorine → phosphorus trichloride

_____ b) zinc hydroxide + hydrogen chloride → zinc chloride + hydrogen hydroxide
