

17.3 Classifying Reactions

READ

Chemical reactions may be classified into different groups according to the reactants and products. The five major groups of chemical reactions are summarized below.

Addition reactions - when two or more substances combine to form a new compound.

- *General equation:* $A + B \rightarrow AB$
- *Example:* When rust forms, iron reacts with oxygen to form iron oxide (rust).
 $4\text{Fe (s)} + 3\text{O}_2 \text{ (g)} \rightarrow 2\text{Fe}_2\text{O}_3 \text{ (s)}$

Decomposition reactions - when a single compound is broken down to produce two or more smaller compounds.

- *General equation:* $AB \rightarrow A + B$
- *Example:* Water can be broken down into hydrogen and oxygen gases.
 $2\text{H}_2\text{O (l)} \rightarrow 2\text{H}_2 \text{ (g)} + \text{O}_2 \text{ (g)}$

Single displacement reactions - when one element replaces a similar element in a compound.

- *General equation:* $A + \text{BX} \rightarrow \text{AX} + \text{B}$
- *Example:* When iron is added to a solution of copper chloride, iron replaces copper in the solution and copper falls out of the solution.
 $\text{Fe (s)} + \text{CuCl}_2 \text{ (aq)} \rightarrow \text{Cu (s)} + \text{FeCl}_2 \text{ (aq)}$

Double displacement reactions - when ions from two compounds in solution exchange places to produce two new compounds.

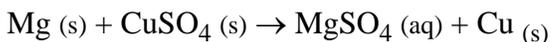
- *General equation:* $\text{AX} + \text{BY} \rightarrow \text{AY} + \text{BX}$
- *Example:* When carbon dioxide gas is bubbled into lime water, a precipitate of calcium carbonate is formed along with water.
 $\text{CO}_2 \text{ (g)} + \text{CaO}_2\text{H}_2 \text{ (aq)} \rightarrow \text{CaCO}_3 \text{ (s)} + \text{H}_2\text{O (l)}$

Combustion reactions - when a carbon compound reacts with oxygen gas to produce carbon dioxide and water vapor. Energy is released from the reaction.

- *General equation:* Carbon Compound + $\text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O} + \text{energy}$
- *Example:* The combustion of methane gas.
 $\text{CH}_4 \text{ (g)} + 2\text{O}_2 \rightarrow \text{CO}_2 \text{ (g)} + 2\text{H}_2\text{O (g)}$

EXAMPLE

Classify the following reaction as addition, decomposition, single displacement, double displacement, or combustion. Explain your answer.



Answer: Displacement. Magnesium replaces copper in the compound.

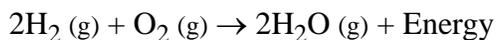
PRACTICE 

Classify the reactions below as either: addition, decomposition, single displacement, double displacement, or combustion. Explain your answers.

1. $\text{CO}_2 (\text{g}) + \text{H}_2\text{O} (\text{l}) \rightarrow \text{H}_2\text{CO}_3 (\text{aq})$
2. $\text{Cl}_2 (\text{g}) + 2\text{KI} (\text{aq}) \rightarrow 2\text{KCl} (\text{aq}) + \text{I}_2 (\text{g})$
3. $\text{H}_2\text{O}_2 (\text{l}) \rightarrow \text{H}_2\text{O} (\text{l}) + \text{O}_2 (\text{g})$
4. $\text{MnSO}_4 (\text{s}) \rightarrow \text{MnO} (\text{s}) + \text{SO}_3 (\text{g})$
5. $\text{C}_6\text{H}_{12}\text{O}_6 (\text{s}) + 6\text{O}_2 (\text{g}) \rightarrow 6\text{CO}_2 (\text{g}) + 6\text{H}_2\text{O} (\text{g})$
6. $\text{CaCl}_2 (\text{aq}) + 2\text{AgNO}_3 (\text{aq}) \rightarrow \text{Ca}(\text{NO}_3)_2 (\text{aq}) + 2\text{AgCl} (\text{s})$
7. $2\text{NaCl} (\text{aq}) + \text{CuSO}_4 (\text{aq}) \rightarrow \text{Na}_2\text{SO}_4 (\text{aq}) + \text{CuCl}_2 (\text{s})$
8. $\text{CaCl}_2 (\text{aq}) + 2\text{Na} (\text{s}) \rightarrow \text{Ca} (\text{s}) + 2\text{NaCl} (\text{aq})$
9. $\text{CaCO}_3 (\text{s}) \rightarrow \text{CaO} (\text{s}) + \text{CO}_2 (\text{g})$
10. $\text{C}_3\text{H}_8 (\text{g}) + 5\text{O}_2 (\text{g}) \rightarrow 3\text{CO}_2 (\text{g}) + 4\text{H}_2\text{O} (\text{g})$

Answer the following questions.

11. You mix two clear solutions. Instantly, you see a bright yellow precipitate form. What type of reaction did you just observe? Explain your answer.
12. What type of reaction occurs when you strike a match?
13. Solid sodium reacts violently with chlorine gas. The product formed in the reaction is sodium chloride, also known as table salt. What type of reaction is this? Explain your answer.
14. Hydrogen-powered cars burn hydrogen gas to produce water and energy. The reaction is:



While this reaction can be classified as an addition reaction, it is sometimes referred to as combustion. What characteristics does this reaction share with other combustion reactions? How is it different?