Section 3: Reaction Types

Preview

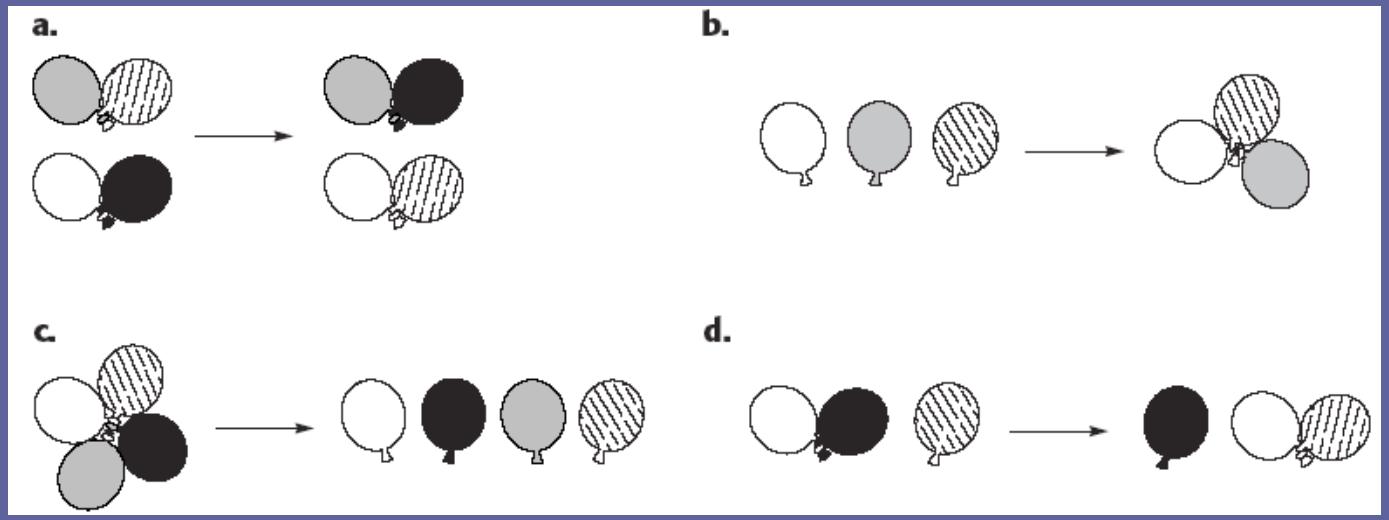
Key Ideas

- How does learning about reaction types help in understanding chemical reactions?
- In which kinds of chemical reactions do the numbers of electrons in atoms change?

Bellringer

There are thousands of ways that more than one hundred elements can combine with each other to form different substances. Just as the elements can be sorted into families, the many reactions the elements undergo can be classified as a few basic types. The types of reactions are classified based on whether they involve combining atoms or smaller molecules to make larger molecules (synthesis), breaking down larger molecules into atoms or smaller molecules (decomposition), or having atoms of one element replace the atoms of another element within a compound (single-displacement or double-displacement).

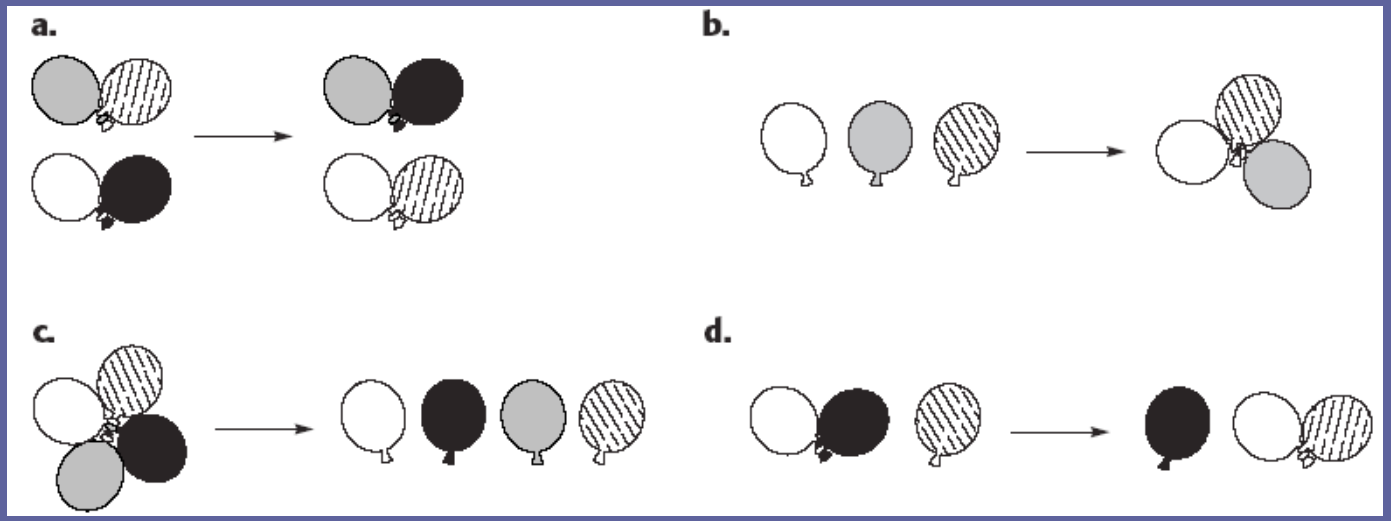
Bellringer, *continued*



1. In which reaction model do three "elements" combine to make a compound?

2. In which reaction model is a complex substance broken down into simpler parts?

Bellringer, *continued*



3. Identify the reaction model in which one element reacts with a compound, leaving behind another element and a new compound containing the first element.

4. In which reaction model do two compounds react to form two different compounds?

Classifying Reactions

- How does learning about reaction types help in understanding chemical reactions?

- You can use patterns to identify kinds of chemical reactions and to predict the products of the chemical reactions.

Classifying Reactions, *continued*

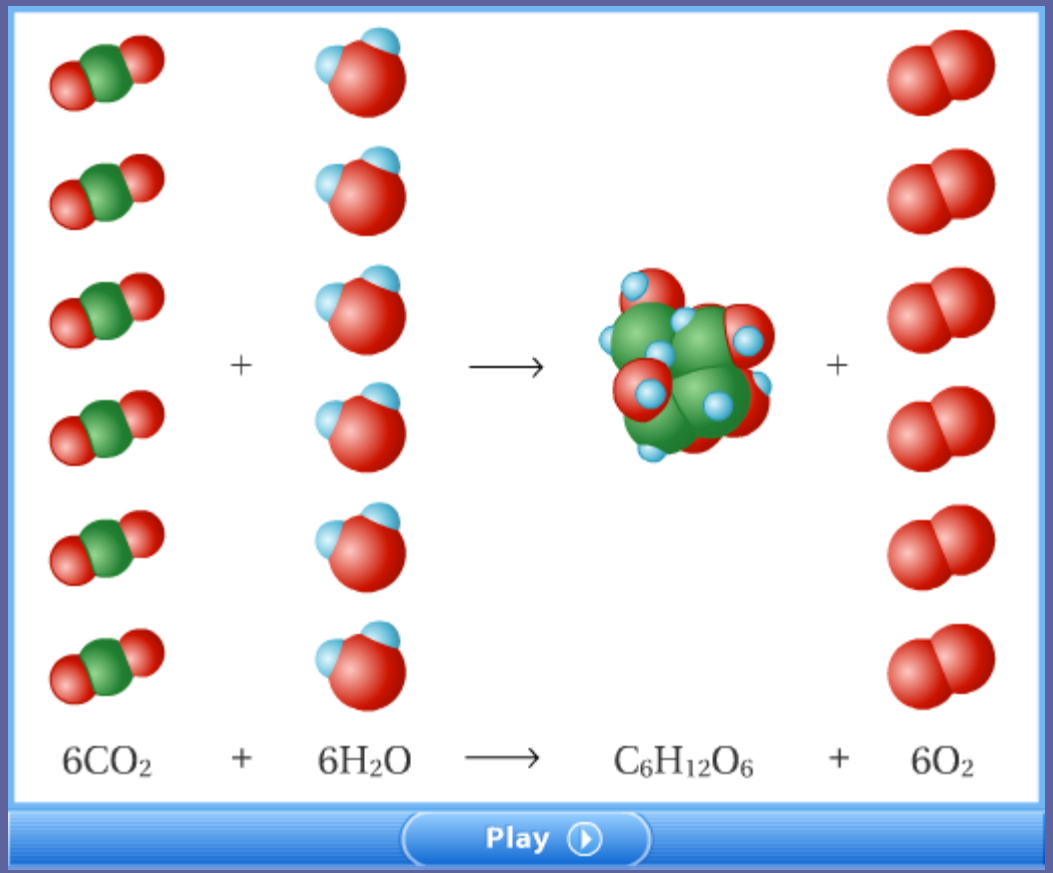
- Synthesis reactions combine substances.
  - **synthesis reaction:** a reaction in which two or more substances combine to form a new compound

  - The general form of a synthesis reaction is:

$$A + B \rightarrow AB$$

  - Example: $2Na + Cl_2 \rightarrow 2NaCl$

Visual Concept: Synthesis Reaction



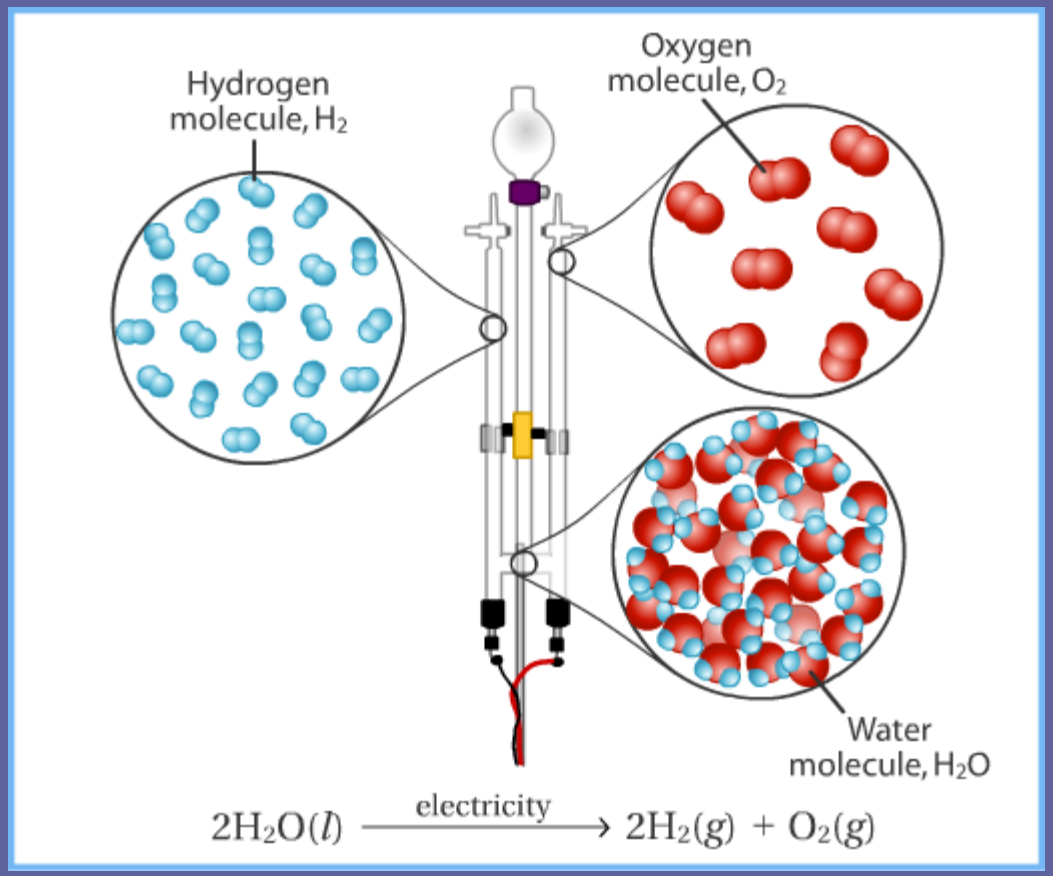
Classifying Reactions, *continued*

- Decomposition reactions break substances apart.
  - **decomposition reaction:** a reaction in which a single compound breaks down to form two or more simpler substances
  - Decomposition reactions have the general form:

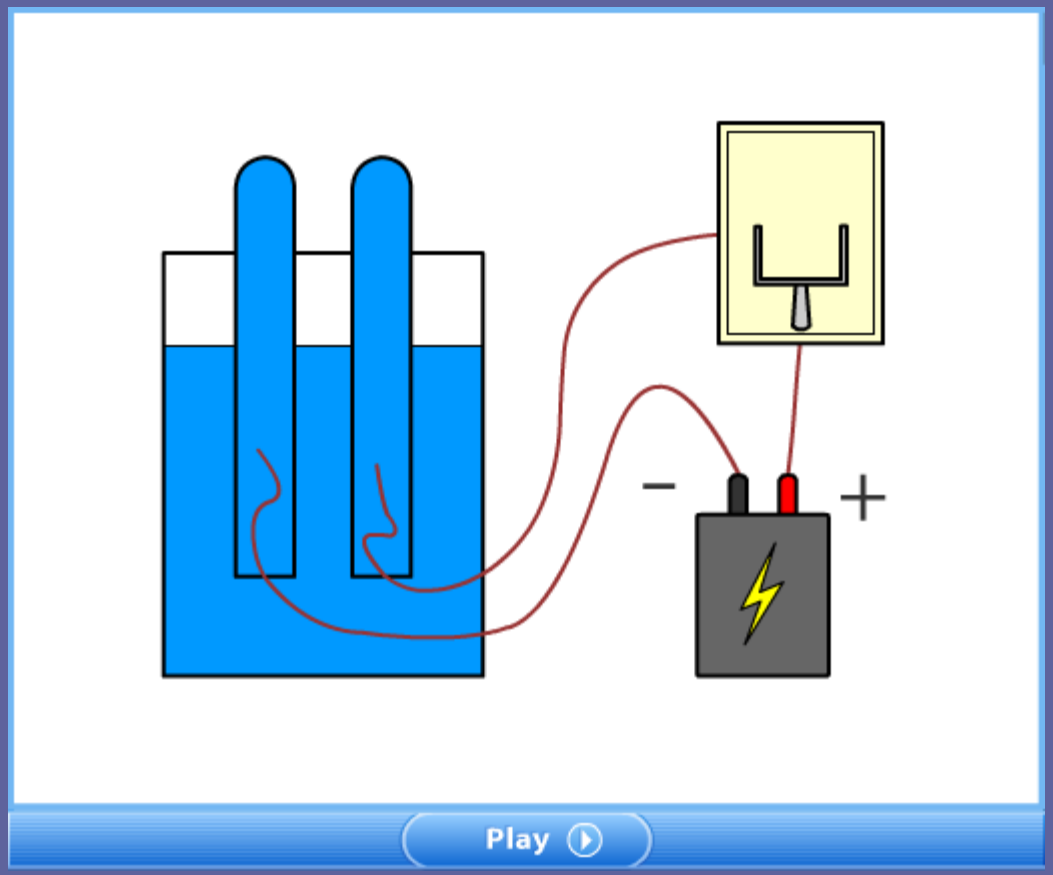
$$AB \rightarrow A + B$$

  - Example: $2H_2O \rightarrow 2H_2 + O_2$

Visual Concept: Decomposition Reaction



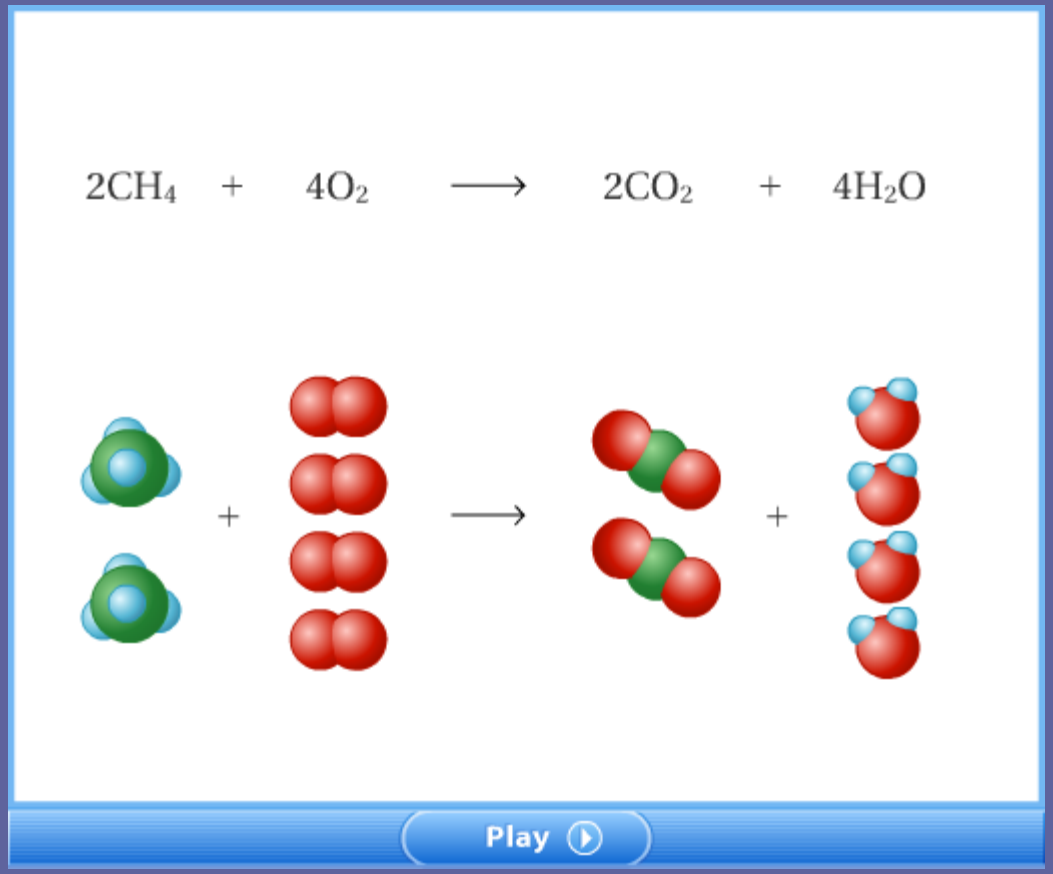
Visual Concept: Electrolysis



Classifying Reactions, *continued*

- Combustion reactions use oxygen as a reactant.
  - **combustion reaction:** the oxidation reaction of an organic compound, in which heat is released
    - Water is a common product of combustion reactions.
- In combustion reactions, the products depend on the amount of oxygen available for the reaction.
  - When there is not enough oxygen during a combustion reaction, fuels are not converted completely into carbon dioxide.

Visual Concept: Combustion Reaction



Classifying Reactions, *continued*

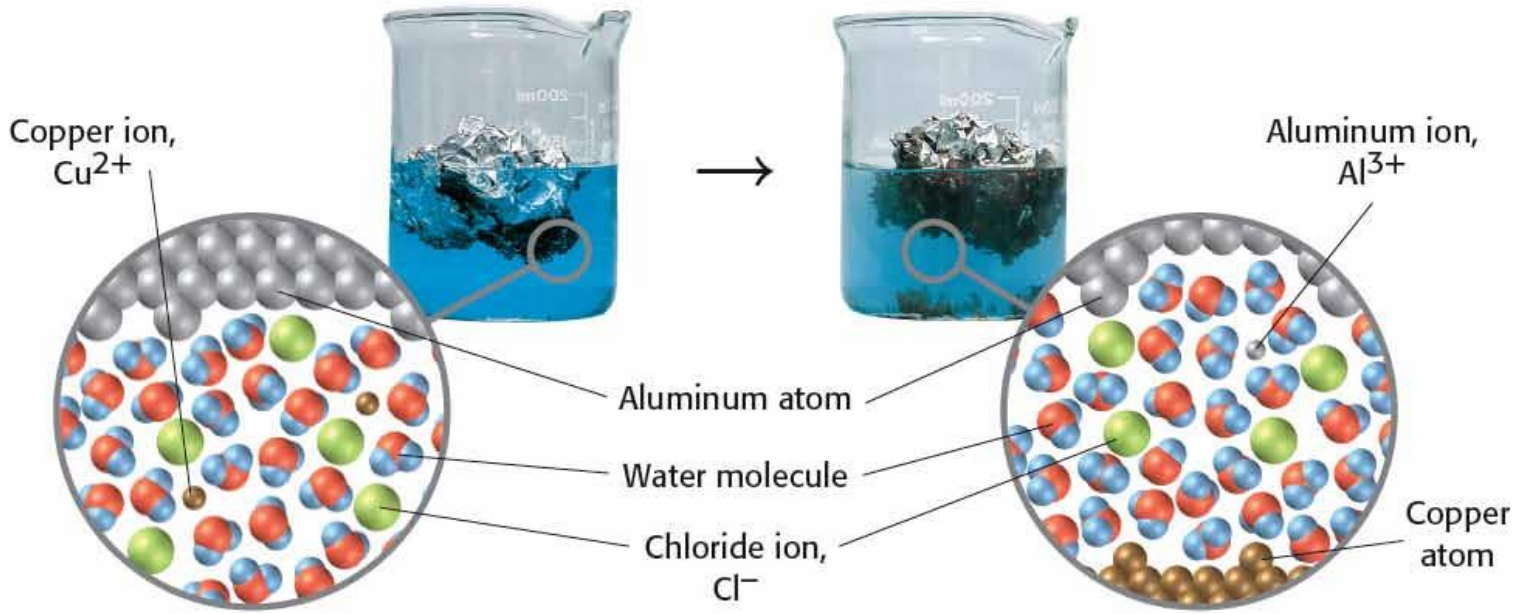
- In single-displacement reactions, elements trade places.
  - **single-displacement reaction:** a reaction in which one element or radical takes the place of another element or radical in a compound
  - In general, a more reactive element will take the place of a less reactive one.
  - All alkali metals and some other metals undergo similar single-displacement reactions with water.
  - Single-displacement reactions have the general form:

$$AX + B \rightarrow BX + A$$

- Example: $3CuCl_2 + 2Al \rightarrow 2AlCl_3 + 3Cu$

Single Displacement

$$3CuCl_2 + 2Al \rightarrow 2AlCl_3 + 3Cu$$



Classifying Reactions, *continued*

- In double-displacement reactions, ions appear to be exchanged between compounds.
  - **double-displacement reaction:** a reaction in which a gas, a solid precipitate, or a molecular compound forms from the apparent exchange of atoms or ions between two compounds
  - Double-displacement reactions have the general form:

$$AX + BY \rightarrow AY + BX$$

  - Example: $Pb(NO_3)_2 + K_2CrO_4 \rightarrow PbCrO_4 + 2KNO_3$

Double-Displacement Reaction

Electrons and Chemical Reactions

〉 In which kinds of chemical reactions do the numbers of electrons in atoms change?

〉 Free-radical reactions and redox reactions can be understood as changes in the numbers of electrons that atoms have.

- **oxidation-reduction reaction:** any chemical change in which one species is oxidized (loses electrons) and another species is reduced (gains electrons); also called *redox reaction*

Electrons and Chemical Reactions, *continued*

- Substances that accept electrons are said to be *reduced.*
  - The gain of electrons reduces the positive charge on an ion.
- Substances that give up electrons are said to be *oxidized.*
- Some redox reactions do not involve ions.
- Free radicals have electrons available for bonding.
  - **free radical:** an atom or a group of atoms that has one unpaired electron
  - Polymerization reactions often involve free radicals.

Visual Concept: Redox Reactions