

# BC Science CONNECTIONS 10

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Unit 2: Chemical processes require energy change as  
atoms are rearranged.

## Topic 2.4: How do atoms rearrange in different types of chemical reactions?

- A compound forms in a synthesis reaction and breaks down in a decomposition reaction.
- In replacement reactions, elements replace other elements.
- Most combustion reactions release heat and light.
- In a neutralization reaction, an acid reacts with a base.

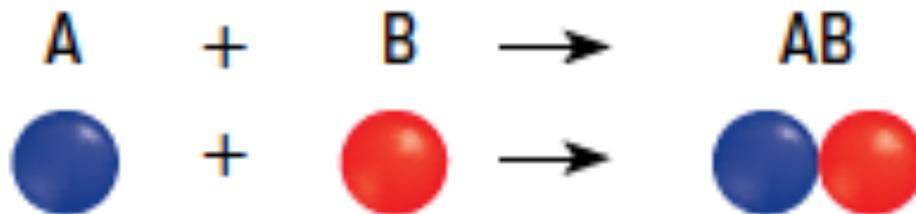


## Concept 1: A compound forms in a synthesis reaction and breaks down in a decomposition reaction.

- **Synthesis reaction:** a chemical reaction in which two or more reactants combine to produce a single product



- Most synthesis reactions are exothermic.



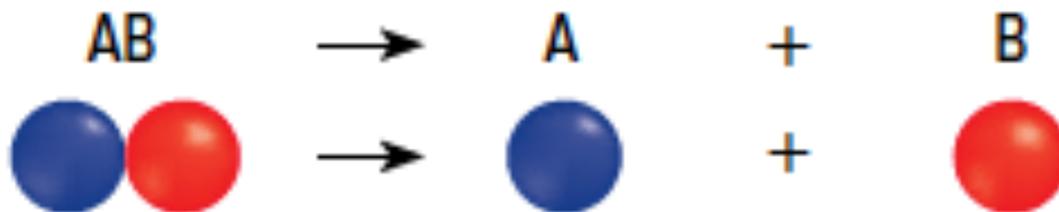
Synthesis reaction (p. 156)

## Decomposition Reactions

- **Decomposition reaction:** a chemical reaction in which a compound is broken down into elements or simpler compounds



- Most decomposition reactions are endothermic.



Decomposition reaction (p. 158)

## Discussion Questions

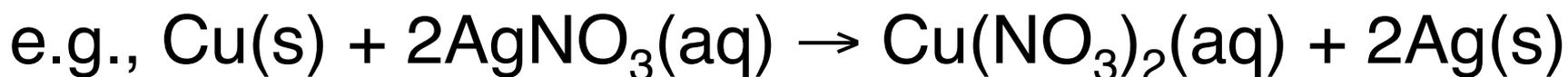
1. In your own words, describe what happens in a synthesis reaction and a decomposition reaction.
2. Which of the following is a synthesis reaction and which is a decomposition reaction? Predict the products formed in each reaction, and give the balanced chemical equations.
  - a)  $\text{Al(s)} + \text{F}_2\text{(g)} \rightarrow$
  - b)  $\text{AgCl(s)} \rightarrow$

## Discussion Questions (cont'd)

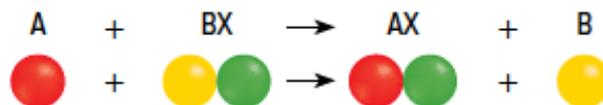
3. Are decomposition reactions endothermic or exothermic? Justify your response through a discussion of the energy changes associated with breaking and forming bonds.

## Concept 2: In replacement reactions, elements replace other elements.

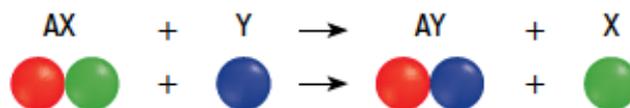
- **Single replacement reaction:** a chemical reaction in which an element and a compound react to produce another element and another compound



Reactions in which a metal replaces another metal:



Reactions in which a non-metal replaces another non-metal:



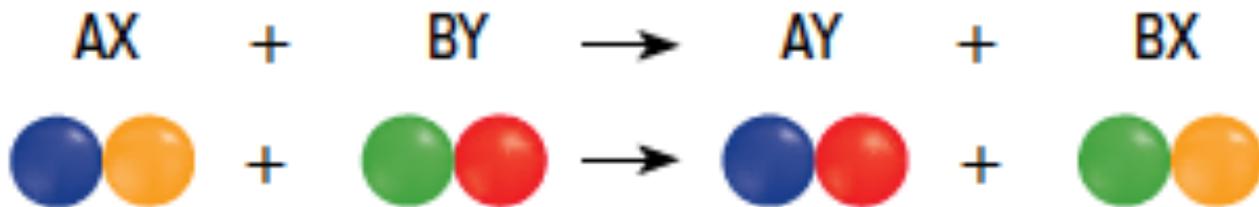
Single replacement reactions (p. 160)

## Double Replacement Reactions

- **Double replacement reaction:** a chemical reaction in which solutions of two ionic compounds react to produce two new compounds



- A precipitate is usually produced in a double replacement reaction.



Double replacement reactions (p. 163)

## Discussion Questions

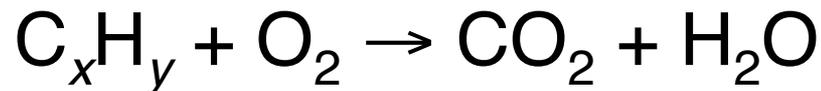
1. Give the predicted products and the balanced chemical equations.
  - a)  $\text{Mg(s)} + \text{AgCl(aq)} \rightarrow$
  - b)  $\text{AgNO}_3\text{(aq)} + \text{K}_2\text{CrO}_4\text{(aq)} \rightarrow$
2. Identify each reaction in question 1 as single or double replacement.

## Discussion Questions (cont'd)

3. In your own words, describe what happens in a single replacement reaction.

## Concept 3: Most combustion reactions release heat and light.

- **Combustion reaction:** a chemical reaction in which a compound or element reacts with oxygen to produce an oxide of the element
- Many combustion reactions produce heat and light.
  - A *hydrocarbon* is a compound that consists of carbon and hydrogen.
  - The general equation for the combustion of hydrocarbon is



## Incomplete Combustion

- Incomplete combustion occurs when low amounts of oxygen are available.
- It produces carbon dioxide and water.
- It also produces carbon monoxide and soot.

## Discussion Questions

1. What energy changes are associated with hydrocarbon combustion?
2. What are the products of the complete combustion of a hydrocarbon?

## Concept 4: In a neutralization reaction, an acid reacts with a base.

- **Acid:** compound that forms  $\text{H}^+$  ions when dissolved in water
- Two categories for acids:
  - 1) **Binary acids:** consist of hydrogen and non-metal (e.g.,  $\text{HCl}$ )
  - 2) **Oxyacids:** consist of hydrogen, oxygen, and another element (e.g.,  $\text{H}_2\text{CO}_3$ )
- The chemical formula for an acid has an “H” in it.

## Acids (cont'd)

**Table 2.1** Common Acids and Their Uses

Chemical Formula	Classical Name	IUPAC Name	Uses
HCl(aq)	hydrochloric acid	aqueous hydrogen chloride	producing plastics and processing metals
HF(aq)	hydrofluoric acid	aqueous hydrogen fluoride	manufacturing and etching glass
H <sub>2</sub> SO <sub>4</sub> (aq)	sulfuric acid	aqueous hydrogen sulfate	in car batteries
HNO <sub>3</sub> (aq)	nitric acid	aqueous hydrogen nitrate	making explosives and fertilizers
H <sub>2</sub> CO <sub>3</sub> (aq)	carbonic acid	aqueous hydrogen carbonate	in carbonated drinks
CH <sub>3</sub> COOH(aq)	acetic acid	aqueous hydrogen acetate, or ethanoic acid	in vinegar

# Bases

- **Base:** a compound that forms  $\text{OH}^-$  ions when dissolved in water
- The chemical formula for a base has an “OH” in it.

**Table 2.2** Common Bases and Their Uses

Chemical Formula	Common Name	IUPAC Name	Uses
$\text{NaOH(aq)}$	lye, caustic soda	sodium hydroxide	in drain cleaners, used in making soaps and paper
$\text{Mg(OH)}_2\text{(aq)}$	Milk of Magnesia <sup>®</sup>	magnesium hydroxide	antacids and laxatives
$\text{Ca(OH)}_2\text{(aq)}$	lime water	calcium hydroxide	soil and water treatment

## Identifying Acids and Bases

- **Acid-base indicators** can be used to identify acids and bases by changing colour, e.g., litmus paper.

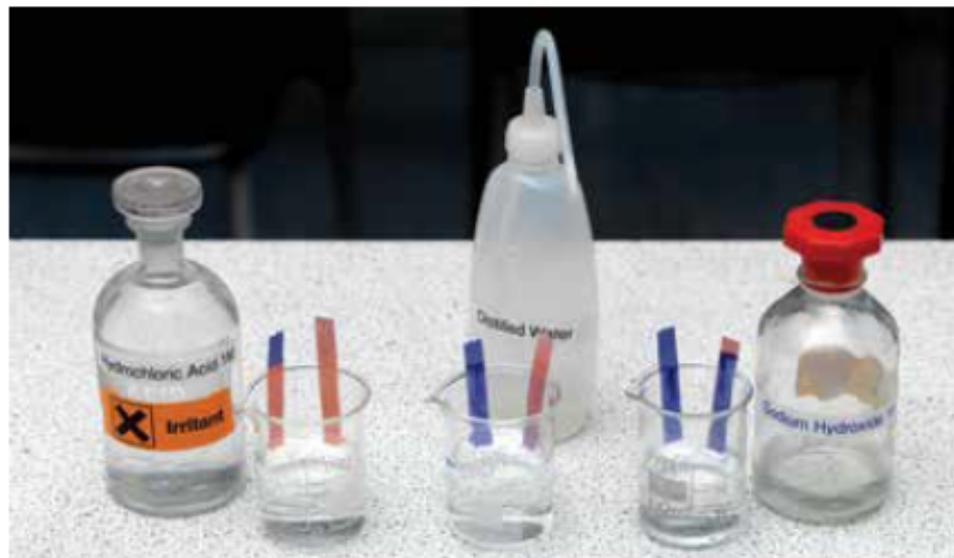


Figure 2.39: Blue litmus paper turns red in an acidic solution, and red litmus paper turns blue in a basic solution.

## The pH Scale

- The **pH scale** is used to measure pH.
  - It ranges from 0 to 14.
  - Acidic solutions have a pH less than 7.
  - Basic solutions have a pH greater than 7.
  - Neutral solutions have a pH equal to 7.



Figure 2.40: The pH scale ranges from 0 to 14.

## Acid-Base Neutralization

- **Neutralization reaction:** a chemical reaction in which an acid reacts with a base to form salt and water
  - It is a type of double replacement reaction.
  - e.g.,  $\text{HCl(aq)} + \text{NaOH(aq)} \rightarrow \text{H}_2\text{O}(\ell) + \text{NaCl(s)}$

## Topic 2.4 Summary: How do atoms rearrange in different types of chemical reactions?

- A compound forms in a synthesis reaction and breaks down in a decomposition reaction.
- In replacement reactions, elements replace other elements.
- Most combustion reactions release heat and light.
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