

Lesson Overview

Predicting Products of Reactions

Objective: The student will be able to predict the products of a reaction given the reactants.

The 5 Major Classes of Chemical Reactions

Synthesis



Decomposition



Single Replacement



Double Replacement



Combustion

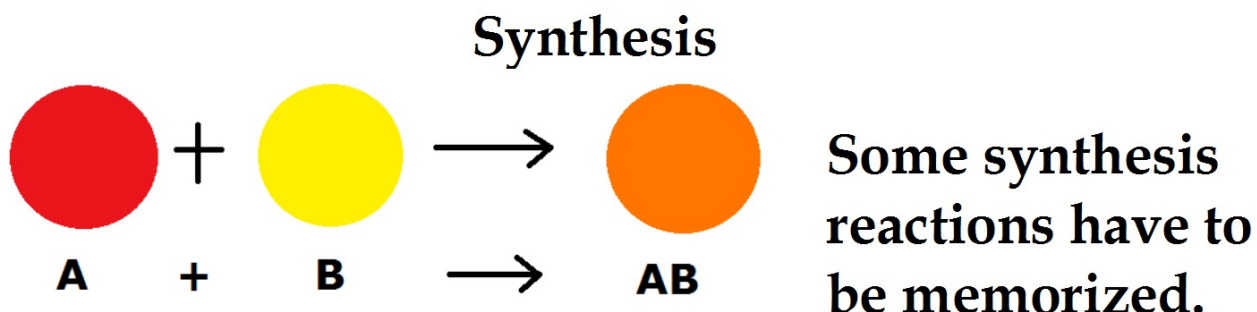
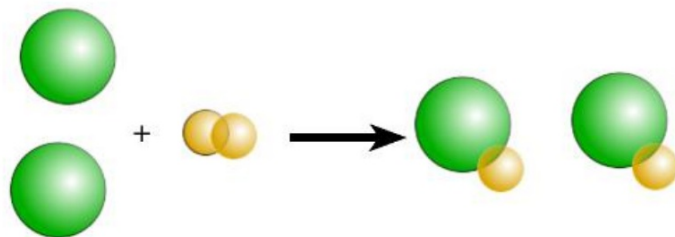


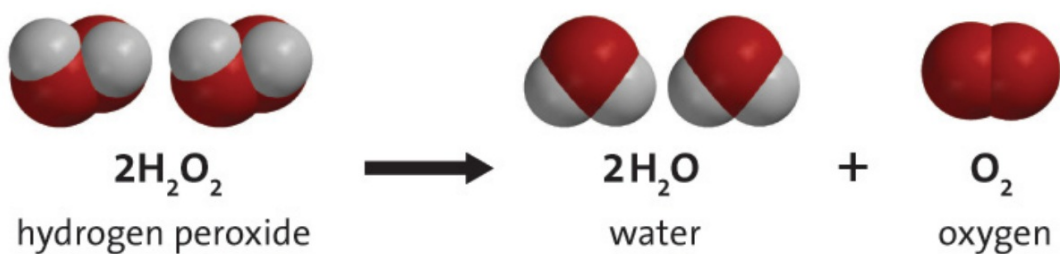
Figure 2.3



SYNTHESIS:

- a. Formation of binary compound: $A + B \rightarrow AB$
- b. Metal oxide and water: $MO + H_2O \rightarrow \text{base}$
- c. Nonmetal oxide and water: $(NM)O + H_2O \rightarrow \text{acid}$

Decomposition



opposite of synthesis reactions

DECOMPOSITION:

- Binary compounds: $\text{AB} \rightarrow \text{A} + \text{B}$
- Metallic carbonates: $\text{MCO}_3 \rightarrow \text{MO} + \text{CO}_2$
- Metallic hydrogen carbonates: $\text{MHCO}_3 \rightarrow \text{MCO}_3(s) + \text{H}_2\text{O}(l) + \text{CO}_2(g)$
- Metallic hydroxides: $\text{MOH} \rightarrow \text{MO} + \text{H}_2\text{O}$
- Metallic chlorates: $\text{MClO}_3 \rightarrow \text{MCl} + \text{O}_2$
- Oxyacids decompose to nonmetal oxides and water: $\text{acid} \rightarrow (\text{NM})\text{O} + \text{H}_2\text{O}$

Single Replacement

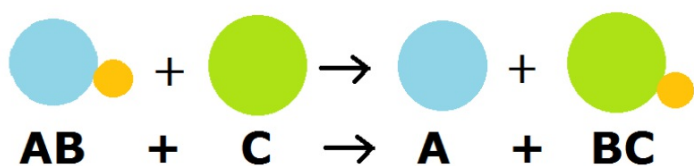


Figure 2.5

In single replacement reactions look to the activity series to see if the reaction takes place.

ACTIVITY SERIES of Metals

Li	↑
Rb	↑
K	↑
Ba	↑
Sr	↑
Ca	↑
Na	↑
Mg	↓
Al	↓
Mn	↓
Zn	↓
Cr	↓
Fe	↓
Cd	↓
Co	↓
Ni	↓
Sn	↓
Pb	↓
[H ₂]	↓
Sb	↓
Bi	↓
Cu	↓
Hg	↓
Ag	↓
Pt	↓
Au	↓

Replace hydrogen from cold water (between Na and Mg)

Replace hydrogen from steam (between Fe and Cd)

Replace hydrogen from acids (between Pb and [H₂])

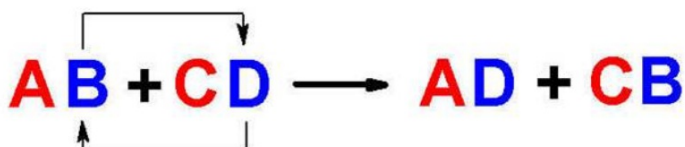
React with oxygen to form oxides (between Cu and Hg)

SINGLE REPLACEMENT:

- Metal-Metal replacement: $A + BC \rightarrow AC + B$
- Active metal replaces H from water: $M + H_2O \rightarrow MOH + H_2$
- Active metal replaces H from acid: $M + HX \rightarrow MX + H_2$
- Halide-Halide replacement: $D + BC \rightarrow BD + C$

Double Replacement Reactions

Double Replacement Reactions
or
Ion Exchange Reactions



The ions do NOT change their charges in Ion Exchange Reactions!

Soluble:

- All Nitrates, Acetates, Ammonium, and Group 1 (IA) salts
- All Chlorides, Bromides, and Iodides, except Silver, Lead, and Mercury(I)
- All Fluorides except Group 2 (IIA), Lead(II), and Iron(III)
- All Sulfates except Calcium, Strontium, Barium, Mercury, Lead(II), and Silver

Insoluble (0.10 M or greater):

- All Carbonates and Phosphates except Group 1 (IA) and Ammonium
- All Hydroxides except Group 1 (IA), Strontium, Barium, and Ammonium
- All Sulfides except Group 1 (IA), 2 (IIA), and Ammonium
- All Oxides except Group 1 (IA)

In double replacement reactions look at the solubility rules

Example 1: Synthesis

Write a complete, balanced reaction for the following situation:

combining solid silver and chlorine gas

Example 2: Single Replacement

Write a complete, balanced reaction for the following situation:

mixing aqueous silver nitrate and solid copper

ACTIVITY SERIES of Metals

Li	↑	
Rb	↑	
K	↑	
Ba	↑	
Sr	↑	
Ca	↑	
Na	↑	
Mg	↑	
Al	↑	
Mn	↑	
Zn	↑	
Cr	↑	
Fe	↑	
Cd	↑	
Co	↑	
Ni	↑	
Sn	↑	
Pb	↑	
[H ₂]	↑	
Sb	↓	
Bi	↓	
Cu	↓	
Hg	↓	
Ag	↓	
Pt	↓	
Au	↓	

Replace hydrogen from cold water

Replace hydrogen from steam

Replace hydrogen from acids

React with oxygen to form oxides

Example 3: Double Replacement

Write a complete, balanced reaction for the following situation:

mixing solutions of lead (II) chlorate and sodium sulfide