Chemical Reactions

Every reaction has two things in common:

1. Reactants (before arrow)
2. Products (after arrow)

$$2\,SO_{2(g)} + O_{2(g)} \longrightarrow 2\,SO_{3(g)}$$

Reactants **Products**

Chemical equation- a chemical reaction written out using symbols
Word equation- a chemical reaction written out with words

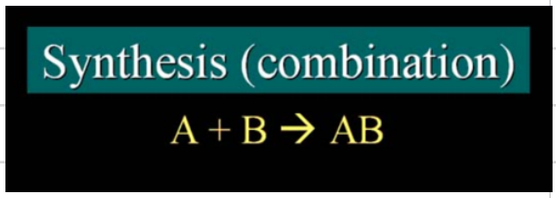
Common Chemical Reaction Symbols:

Yields →
Reversible ⇌
Solid (s) or (cr)
Liquid (l)
Gas (g)
Aqueous (aq) (in a solution)
Precipitate as a product ↓
Alternative to gas ↑

Types of Reactions

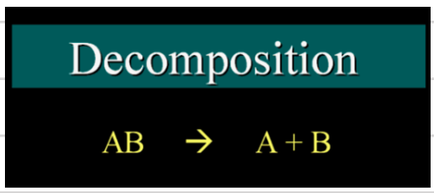
1. Synthesis- the reactants combine to create one product

$Mg_{(s)} + O_{2(g)} \longrightarrow MgO_{(s)}$



2. Decomposition- one reactant breaking into multiple products

$H_2CO_{3(aq)} \rightarrow CO_{2(g)} + H_2O_{(l)}$ (soda)

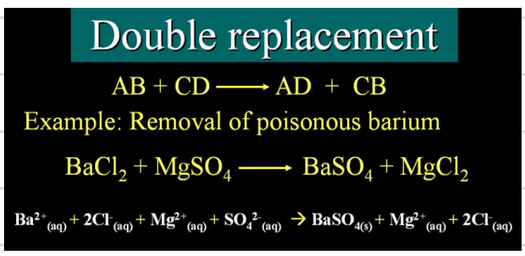


3. Single Replacement (displacement)- reaction in which an element displaces an element in a compound to make a new element and compound

$2HCl_{(aq)} + Mg_{(s)} \longrightarrow MgCl_{2(aq)} + H_{2(g)}$

4. Double Replacement (metathesis)- reaction between two compounds involving an exchange of partners.

$HCl_{(aq)} + NaOH_{(aq)} \longrightarrow \underset{(H_2O)}{HOH_{(l)}} + NaCl_{(aq)}$

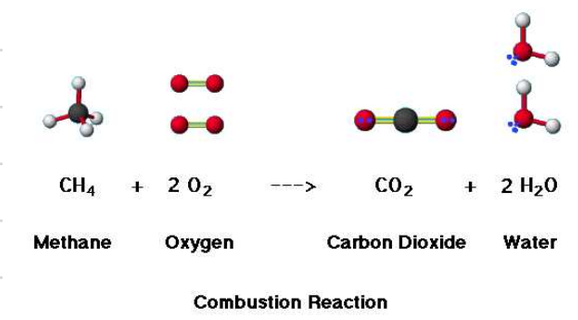


*in order for the reaction to be a double replacement, one of three indicators must be present:

- •a precipitate must be formed
- •a gas must be released
- •water must be formed

5. Combustion- a reaction between a hydrocarbon and oxygen that results in water and carbon dioxide (complete) or carbon and carbon monoxide (incomplete)

$CH_{4(g)} + 2O_{2(g)} \longrightarrow CO_{2(g)} + 2H_2O_{(l)}$



The Solubility Rules

1. All common salts of the Group 1A elements and ammonium are soluble.
2. All common acetates and nitrates are soluble.
3. All binary compounds of Group VIIA elements (other than F) with metals are soluble except those of silver, mercury (I), and lead.
4. All sulfates are soluble except those of barium, strontium, lead, calcium, silver, and mercury(I).
5. Except for those in Rule 1, carbonates, hydroxides, oxides, and phosphates are insoluble.

A more complete solubility chart can be found at http://www.austincc.edu/chemlab/solubility.htm

Table 17.3 Solubilities of Ionic Compounds* aq = aqueous (dissolves in water); s = solid (does not dissolve in water)

Ions	Acetate	Bromide	Carbonate	Chlorate	Chloride	Fluoride	Hydrogen Carbonate	Hydroxide	Iodide	Nitrate	Nitrite	Phosphate	Sulfate	Sulfide	Sulfite
Aluminum	s	aq		aq	aq	s		s	—	aq		s	aq	—	
Ammonium	aq	aq	aq	aq	aq	aq	aq	—	aq	aq	aq	aq	aq	aq	aq
Barium	aq	aq	s	aq	aq	s		aq	aq	aq	aq	s	s	—	s
Calcium	aq	aq	s	aq	aq	s		s	aq	aq	aq	s	s	—	s
Cobalt(II)	aq	aq	s	aq	aq	—		s	aq	aq		s	aq	s	s
Copper(II)	aq	aq	s	aq	aq	aq		s		aq		s	aq	s	
Iron(II)	aq	aq	s		aq	s		s	aq	aq		s	aq	s	s
Iron(III)	—	aq			aq	s		s	aq	aq		s	aq	—	
Lead(II)	aq	s	s	aq	s	s		s	s	aq	aq	s	s	s	s
Lithium	aq	aq	aq	aq	aq	aq	aq	aq	aq	aq	aq	s	aq	aq	aq
Magnesium	aq	aq	s	aq	aq	s		s	aq	aq	aq	s	aq	—	aq
Nickel	aq	aq	s	aq	aq	aq		s	aq	aq		s	aq	s	s
Potassium	aq	aq	aq	aq	aq	aq	aq	aq	aq	aq	aq	aq	aq	aq	aq
Silver	s	s	s	aq	s	aq		—	s	aq	s	s	s	s	s
Sodium	aq	aq	aq	aq	aq	aq	aq	aq	aq	aq	aq	aq	aq	aq	aq
Zinc	aq	aq	s	aq	aq	aq		s	aq	aq		s	aq	s	s

Determining Whether Reactions Occur

Li	Lithium	Most Reactive
K	Potassium	
Ba	Barium	
Sr	Strontium	
Ca	Calcium	
Na	Sodium	
Mg	Magnesium	
Al	Aluminum	
Mn	Manganese	
Zn	Zinc	
Cr	Chromium	
Fe	Iron	
Cd	Cadmium	
Co	Cobalt	
Ni	Nickel	
Sn	Tin	
Pb	Lead	
H	Hydrogen	
Sb	Antimony	
As	Arsenic	
Bi	Bismuth	
Cu	Copper	
Hg	Mercury	
Ag	Silver	
Pt	Platinum	
Au	Gold	Least Reactive

Single replacement

ex: Al + HCl --> H2 + AlCl3

•In a double replacement reaction, the metals always switch.

•to determin if a reaction will occur, use the Activity Series of Metals (the elements at the top are the most reactive, the elements on the bottom are the least reactive)

•If the metal being replaced is less reactive than the metal replacing it, then

Double Replacement

ex: Ca(OH)2 + 2HNO3 --> Ca(NO3)2 + 2H2O

•In a double replacement, the partners are switched.

•reactions can only occur if a precipitate (s) is formed, a gas (g) is released, or H2O (HOH) is formed.

Synthesis

•A synthesis reaction only occurs if a metal is bonding with a nonmetal.

*special cases:

1. Metal oxide + water ==> base (ends in OH)
   MgO + H2O --> Mg(OH)2
2. Nonmetal oxide + water ==> acid (starts with H)
   CO2 + H2O --> H2CO3 (Carbonic acid)