Chemical Reaction

5 Types

5 Types of Reactions

- Synthesis
- Combustion
- Decomposition
- Single Displacement
- Double Displacement

Synthesis

- combination of two or more reactants to form a more complex substance (product)
- A + B ---> AB
- ie.: $2\ H_{2(l)} + O_{2(l)} \text{ ---> } 2\ H_2O_{(g)}$

Synthesis: Acid Rain

Car exhaust reacts with oxygen:

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

sulfur trioxide reacts with water vapour in the air:

$$SO_{3(g)} + H_2O_{(l)} \longrightarrow H_2SO_{4(aq)}$$

Combustion

- Although it is common to call any reaction with O_2 a combustion reaction, we will refer to it as follows:

$$\mathbf{2}\ C_8H_{18(g)} + \mathbf{25}\ O_{2(g)} \longrightarrow \mathbf{16}\ CO_{2(g)} + \mathbf{18}\ H_2O_{(g)}$$

fuel (hydrocarbon)	oxygen	carbon dioxide	water vapour

Decomposition

- breakdown of larger, complex substances into smaller, simpler entities
- AB ---> A + B
- ie.: $2\ H_2O_{2(l)} \text{---} > 2\ H_2O_{(l)} + O_{2(g)}$

Decompostion: Death of the Gummy Bear

Starts with decomposition:

$$2\ KClO_{3(g)} \longrightarrow 2\ KCl_{(l)} + 3\ O_{2(g)}$$

Then combustion:

$$C_6H_{12}O_{6(s)} + 6\ O_{2(g)} \longrightarrow 6\ CO_{2(g)} + 6\ H_2O$$

Practice:

- p. 53, Q's# 1 & 2

Single Displacement

- Most metals occur naturally as ores *(oxides - MgO, sulfides, halides, carbonates, sulfates, silicates)*
- To isolate the metals from their ores:

1) react them with a solution to form an aqueous salt

2) replace one element with another (usually cheaper) in order to isolate the desired metal

Examples

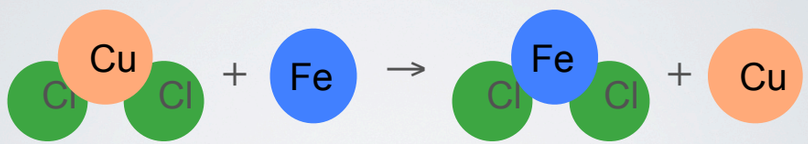
Examples:

1) $CuO_{(s)} + H_2SO_{4(aq)} \longrightarrow CuSO_{4(aq)} + H_2O_{(l)}$

1b) $CuSO_{4(aq)} + Fe_{(s)} \longrightarrow FeSO_{4(aq)} + Cu_{(s)}$

Types: Single displacement

Example: $Fe + CuCl_2$



General: AB + C → CB + A

The Activity Series

Experiments reveal trends. The **activity series** ranks the relative reactivity of metals.

It allows us to predict if certain chemicals will undergo single displacement reactions when mixed: metals near the top are most reactive and will displacing metals near the bottom.

Q: Which of these will react?

$Fe_{(s)} + CuSO_{4(aq)} \rightarrow$ $Cu_{(s)} + Fe_2(SO_4)_{3(aq)}$

$Ni_{(s)} + NaCl_{(aq)} \rightarrow$ NR (no reaction)

$Li_{(s)} + ZnCO_{3(aq)} \rightarrow$ $Zn_{(s)} + Li_2CO_{3(aq)}$

$Al_{(s)} + CuCl_{2(aq)} \rightarrow$ $Cu_{(s)} + AlCl_{3(aq)}$

Li
K
Ca
Na
Mg
Al
Zn
Fe
Ni
Sn
Pb
H
Cu
Hg
Ag
Au

Other Uses for Activity Series

- Anti-Corrosion: Copper plating (lower on the series = less likely to react)
- Galvanizing: Zinc plating (higher on the series, reacts to form insoluble oxide = protection)
- Alloy: Stainless steel - iron, carbon, chromium, nickel = less reactive (chromium) and harder (carbon)

Single Displacement Summary

- used widely in/for metallurgy
- Reactivity series allows us to create more resistive materials - galvanizing and alloys

Double Displacement

General: AB + CD → AD + CB

Identification of NaCl

$NaCl_{(aq)} + AgNO_{3(aq)} \longrightarrow NaNO_{3(?)} + AgCl_{(?)}$

AB + CD ⟶ AD + BC

What are the subscripts on our products?

Use the solubility chart!!!

Solubility Chart

SOLUBILITY OF IONIC COMPOUNDS AT SATP

		Anions						
		Cl^-, Br^-, I^-	S^{2-}	OH^-	SO_4^{2-}	CO_3^{2-}, PO_4^{3-}, SO_3^{2-}	$C_2H_3O_2^-$	NO_3^-
Cations	High solubility (aq) ≥0.1 mol/L	most	Group 1, Group 2, NH_4^{+1}	Group 1, NH_4^{+1}, Sr^{2+}, Ba^{2+}, Tl^+	most	Group 1, NH_4^{+1}	most	all
	Low Solubility (s) <0.1 mol/L	Ag^+, Pb^{2+}, Tl^+, Hg_2^{2+}, Cu^+	most	most	Ag^+, Pb^{2+}, Ca^{2+}, Ba^{2+}, Sr^{2+}, Ra^{2+}	most	Ag^+	none

Identification of NaCl

$$NaCl_{(aq)} + AgNO_{3(aq)} \longrightarrow NaNO_{3(aq)} + AgCl_{(s)}$$

1) Find NO_3^- Is it soluble with Na^+? yes!

$NaNO_3$ is aqueous = (aq)

2) Find Cl^- Is it soluble with Ag^+? NO!

AgCl is non-aqueous = (s) = precipitate