Chapter 21

Chemical Reactions

Section 21.1: Chemical Changes

- **chemical reaction**
  - process in which one or more substances are changed into new substances (chemical change)
- **reactants**
  - substance that reacts
- **product**
  - the new substance that is formed

produce
reactants → products

The Father of Modern Chemistry

- French chemist **Antoine Lavoisier**
  - the father of modern chemistry
  - for his explanation of the conservation of mass and for describing a common type of chemical reaction called combustion
  - **law of conservation of mass**
    - total mass of the products always equals the total mass of the reactants

Writing Equations

- **chemical equation**
  - shorthand method to describe a chemical reaction using chemical formulas and other symbols

Reactants Products

$HgO(s) \rightarrow Hg(l) + O_2(g)$

Writing Equations

(aq) – aqueous (substance dissolved in water)
(s)– solid
(l) – liquid
(g) – gas

coefficients – the numbers to the left of the formulas used to help balance the equation

Section 21.2: Chemical Equations

- **balanced chemical equations**
  - has the same number of atoms of each element on both sides of the equation

Examples

- Use coefficients to balance the following equations.

$NiCl_2(aq) + NaOH(aq) \rightarrow Ni(OH)_2(s) + NaCl(aq)$

$HgO(s) \rightarrow Hg(l) + O_2(g)$

$Mg + O_2 \rightarrow MgO$

$Fe + Cl_2 \rightarrow FeCl_3$

$Fe + O_2 \rightarrow FeO$

$Al + CuO \rightarrow Al_2O_3 + Cu$

$C_3H_8 + O_2 \rightarrow CO_2 + H_2O$

$H_2 + I_2 \rightarrow HI$

$Zn + HCl \rightarrow ZnCl_2 + H_2$

$Pb(NO_3)_2 + AlCl_3 \rightarrow PbCl_2 + Al(NO_3)_3$

$C_3H_6O_3 + O_2 \rightarrow CO_2 + H_2O$

$H_2S + SO_2 \rightarrow S + H_2O$

$K_2O + H_2O \rightarrow KOH$

$Li + H_2O \rightarrow LiOH + H_2$

$H_2 + O_2 \rightarrow H_2O$

$Mg + O_2 \rightarrow MgO$

$C_2H_2 + O_2 \rightarrow CO_2 + H_2O$

$Al(OH)_3 \rightarrow Al_2O_3 + H_2O$

21.3: Classifying Chemical Reactions

- five main types of chemical reactions
  - combustion
  - synthesis
  - decomposition
  - single-displacement
  - double-displacement

Combustion Reactions

- occurs when a substance reacts with oxygen to produce energy in the form of heat and light
- main reactants → O_2 and C_xH_x (hydrocarbon)
- products → **H_2O and CO_2**

- Example
  - $CH_4(g) + O_2(g) \rightarrow H_2O(g) + CO_2(g)$

Synthesis (Combination) Reactions

- two or more substances combine to form another substance

$A + B \rightarrow AB$

- Example:
  - $Mg(s) + O_2(g) \rightarrow MgO(s)$

Decomposition Reactions

- one substance breaks down, or decomposes, into two or more substances

$$AB \rightarrow A + B$$

- Example:
  - $H_2O_2(l) \rightarrow O_2(g) + H_2O(l)$

Single Displacement Reaction

- when one element replaces another element in a compound

$$A + BC \rightarrow AC + B$$

- Example
  - $Zn(s) + HCl(l) \rightarrow ZnCl_2(l) + H_2(g)$

Activity Series

- a list of metals according to how reactive they are
- a metal will replace any other metal that is less active

Double Displacement Reaction

- when the positive ion of one compound replaces the positive ion of the other to form a new compound
- a **precipitate** is usually formed

$$AB + CD \rightarrow CB + AD$$

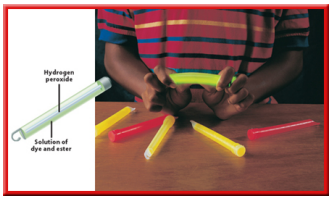
- Example:
  - $AgNO_3(aq) + KCl(aq) \rightarrow KNO_3(aq) + AgCl(s)$

Section 21.4: Chemical Reactions and Energy

- all chemical reactions release or absorb energy
- this energy can take many forms, such as heat, light, sound, or electricity
- chemical bonds are the source of energy

More energy out

- **exergonic reactions**
  - chemical reactions that release energy
- cracking a glow stick is an example of an exergonic reaction



- **exothermic reaction**
  - a chemical reaction that releases energy in the form of heat
- Example
  - burning wood

More energy in

- **endergonic reactions**
  - chemical reaction that requires more energy to break bonds
  - energy absorbed could be in the form of heat, light or electricity

- **endothermic reaction**
  - chemical reaction where energy needed is in the form of heat
- some reactions are so endothermic they can freeze water

Catalysts and Inhibitors

- **catalyst**
  - substance that speeds up a chemical reaction without being permanently changed itself
- when you add a catalyst to a reaction, the mass of the product that is formed remains the same

- sometimes we need to prevent reactions from occurring
- **inhibitors**
  - used to slow down a chemical reaction