SECTION 5.1

Reactants – are substances that undergo a chemical change.

Products – are substances that are the result of a chemical change.

Chemical Equation: \[ 6 \text{ CO}_2 + 6 \text{ H}_2\text{O} \rightarrow \text{ C}_6\text{H}_{12}\text{O}_6 + 6 \text{ O}_2 \]

Reactants          Products

The Following Happens In a Chemical Reaction
Atoms are rearranged in a chemical reaction.
The substance formed will different properties than the reactants.
A color change will occur.
A metal rusting is a chemical reaction.
The experiment produces a gas.
The atoms are rearranged.
The experiment produces a solid precipitate.
The experiment shows a transfer of energy.
Energy is releasing in the form of heat.
Energy is absorbed making the object cold to the touch.

Chemical Energy – is the energy stored within atoms and molecules that can be released when a substance reacts.
The energy source in photosynthesis is light energy.
Most of the energy in an isooctane reaction is released in the form of heat and light.

Exothermic Reaction – is a reaction that transfers energy from the reactants to the surroundings as heat.

Endothermic Reaction – is a reaction in which energy is transferred to the reactants as heat from the surroundings.
**SECTION 5.2 (Six Types of Reactions)**

(1.) **Synthesis Reaction** – is a reaction of at least two substances that forms a new, more complex compound. (Hint: 2 things make 1 thing.)

\[ A + B \rightarrow AB \]
\[ 2Na + Cl_2 \rightarrow 2NaCl \]

(2.) **Decomposition Reaction** – is a reaction in which one compound breaks into at least two products. (Hint: 1 thing breaks down into 2 things.)

\[ AB \rightarrow A + B \]
\[ 2H_2O \rightarrow 2H_2 + O_2 \]

**Electrolysis** – is a type of decomposition reaction. It is a process of breaking (H_2O) water down into hydrogen (H_2) and oxygen (O_2) gas by an electric current.

(3.) **Combustion Reaction** – is a reaction in which a compound and oxygen (O_2) burn. (Hint: Carbon dioxide (CO_2) & water (H_2O) are products and oxygen (O_2) is always a reactant.

\[ C_xH_y + O_2 \rightarrow CO_2 + H_2O \]
\[ 2CH_4 + 4O_2 \rightarrow 2CO_2 + 4H_2O \]

(4.) **Single-displacement Reaction** – is a reaction in which atoms of one element take the place of atoms of another element in a compound.

\[ XA + B \rightarrow BA + X \]
\[ 3CuCl_2 + 2Al \rightarrow 2AlCl_3 + 3Cu \]

(5.) **Double-displacement Reaction** – is a reaction in which a gas, a solid precipitate, or a molecular compound is formed from the apparent exchange of ions between two compounds.

\[ AX + BY \rightarrow AY + BX \]
\[ Pb(NO_3)_2 + K_2CrO_4 \rightarrow PbCrO_4 + 2KNO_3 \]

(1.) **Acid-Base Reaction** – is a reaction in which an acid and a base react to form water (H_2O) and a compound.

\[ HA + BOH \rightarrow H_2O + AB \]
\[ H_2SO_4 + NH_4OH \rightarrow H_2O + (NH_4)_2SO_4 \]

**Facts about Six Types of Reactions**

- Synthesis reactions make larger molecules.
- A synthesis reaction between sodium & chlorine causes sodium chloride to form.
- Decomposition breaks compounds apart.
- Digestion is an example of decomposition reaction.
- Electrolysis is the breakdown of water into oxygen and hydrogen gas.
- In combustion, substances react with oxygen.
- Methane reacting with oxygen gas produces carbon dioxide and water.
Elements appear to trade places in single-displacement reactions. Potassium placed in water causes a single-displacement reaction to occur. In double-displacement reactions, ions appear to move between compounds, resulting in a solid that settles out of solution, a gas that bubbles out of solution, and/or a molecular substance.

**Reduction/Oxidation (Redox) reaction** – is a reaction that occurs when electrons are transferred from one reactant to another. Some redox reactions do not involve ions. In these reactions, oxidation is a gain of oxygen or a loss of hydrogen, and reduction is the loss of oxygen or the gain of hydrogen. In a redox reaction, the substance that accepts electrons is said to be reduced. When iron reacts with oxygen to form rust, each iron atom loses three electrons. In redox reactions, electrons transfer from one substance to another.

**Radicals** - the fragments of molecules that have at least one electron available for bonding.

**SECTION 5.3**

**Chemical Equation** – is an equation that uses chemical formulas and symbols to show the reactants and products in a chemical reaction.

**How to Balance Chemical Equations**

A chemical equation is balanced by changing or adding coefficients. A balanced chemical equation shows the proportions of reactants and products necessary for mass to be conserved. In a balanced chemical reaction, the total mass of the products always equals the total mass of the reactants. A balanced chemical equation indicates both the number of particles of reactants and products and the number of moles. When a chemical reaction and its reverse are occurring at the same time and at the same rate, the reaction has achieved equilibrium. The relationship between chemical equilibrium and the rates of forward and reverse reaction is where in equilibrium, the forward and reverse reaction rates must be equal. Large, bulky molecules react more slowly than small ones because they have less opportunity to collide with other molecules. Increasing the concentration of one substance in an equilibrium reaction favors the reaction that produces less of that substance.

In the reaction \(2H_2O \rightarrow 2H_2 + O_2\), if you start with 2 mol of water, how many moles of hydrogen gas are produced? 2 mol

In the reaction \(2H_2O_2 \rightarrow 2H_2O + O_2\), if you start with 4 mol of \(H_2O_2\), how many moles of \(O_2\) will you end up with? 2 mol

If you start with 5 mol of \(O_2\) in the reaction \(2Mg + O_2 \rightarrow 2MgO\), how many moles of \(Mg\) will you need? 10 mol

In the reaction \(H_2S + 2O_2 \rightarrow H_2SO_4\), the law of definite proportions predicts that for every mole of \(H_2S\) you will need how many moles of \(O_2\)? 2 mol

In the reaction \(2Mg + O_2 \rightarrow 2MgO\), the law of definite proportions states that for every 2 moles of \(Mg\) you will need how many moles of \(O_2\)? 1 mol
Equilibrium – is the state in which a chemical reaction and its reverse occur at the same time and at the same rate.

The following will speed up a chemical reaction
Higher pressure
Higher temperature
Presence of a catalyst
What could you do to make yeast dough rise more slowly? Reduce the temperature

Mole Ratio – is the smallest relative number of moles of the substances involved in a reaction.

SECTION 5.4
Catalyst – is a substance that changes the rate of chemical reactions without being consumed. Most catalysts are used to speed up a reaction.

Enzyme – is a protein that speeds up a specific biochemical reaction. It is also a biocatalyst.

Common Types of Enzymes
1. Amylase – is an enzyme secreted by the salivary glands and the pancreas that helps in the digestion of carbohydrates.
2. Cellulase – an enzyme that breaks down cellulose into smaller molecules
3. Protease – is an enzyme that breaks down proteins into their component peptides.
4. Lipase - a digestive enzyme produced by the pancreas that helps to break down large fatty molecules (triglycerides) into smaller constituent molecules.

Substrate – is the specific substance affected by an enzyme.

Le Châtelier’s Principle – is a general rule that describes the behavior of equilibrium systems.
If a change is made to a system in chemical equilibrium, the equilibrium shifts to oppose the change until a new equilibrium is reached.
Le Châtelier’s principle states that increasing temperature favors a reaction that requires energy as heat.