SECTION 1 (PP. 197-205): Chemical reactions alter arrangements of atoms.

Georgia Standards: S8P1c - *Describe the movement of particles in solids, liquids gases, and plasma states*; S8P1e – *Distinguish between changes in matter as physical (i.e., physical change) or chemical (i.e., development of a gas, formation of a precipitate, and change of color).*

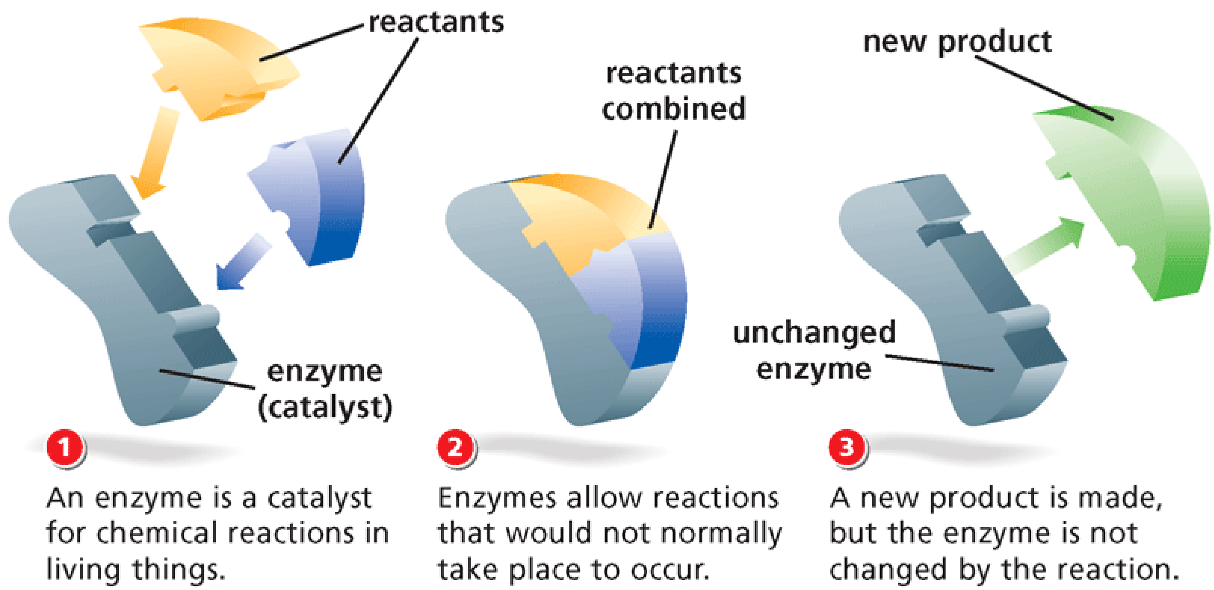
1. **Atoms interact in chemical reactions.**
   Substances change in two ways.
   - In a physical change, the substance itself does not change, although its appearance or some of its properties may change.
   - In a chemical change, one substance changes into a different substance. A ***chemical reaction*** rearranges atoms. Bonds are broken in the ***reactants***, and new bonds are formed in the ***products***.

   Evidence of a chemical reaction includes:
   - Change in color
   - Change in temperature
   - Production of a gas (bubbles form)
   - Production of a participate (solid forms within a liquid)
   - Production of, or change in, odor

2. **Chemical reactions can be classified.**
   - A ***synthesis reaction*** combines two or more simpler reactants to form a new, more complex product (A + B → AB).
   - A ***decomposition reaction*** breaks a reactant into two or more simpler substances. It is the opposite reaction of a synthesis reaction (AB → A + B).
   - A ***combustion reaction*** always involves oxygen. The other reactant often contains carbon and hydrogen.

3. **The rates of chemical reactions can vary.**
   Four factors can change the ***rate*** of a chemical reaction:
   - the ***concentration*** of the reactants
   - the ***surface area*** of the reactants
   - the ***temperature*** of the reaction mixture
   - the presence of a ***catalyst***

A ***catalyst*** takes part in a reaction but is not consumed during the reaction. It decreases the energy needed to start a reaction, and it increases the ***reaction rate***. The diagram below represents the effect of a catalyst, called an ***enzyme***, on a reaction.



SECTION 2 (PP. 206-213): THE MASSES OF REACTANTS AND PRODUCTS ARE EQUAL.

Georgia Standards: S8P1g – *Identify and demonstrate the Law of Conservation of Matter;* S8CS2b – *Demonstrate appropriate techniques in all laboratory situations.*

1. **Careful observations led to the discovery of the conservation of mass.**
   Antoine Lavoisier's careful quantitative experiments showed that in a chemical reaction, the total mass of the reactants is always equal to the total mass of the products. In other words, mass cannot be created or destroyed during a chemical reaction.

2. **Chemical reactions can be described by chemical equations.**
   A ***chemical equation*** represents the way in which a reaction rearranges the atoms in chemicals. To write an equation, you must know the *reactants* and *products*, their *chemical formulas*, and the *direction of the reaction*. The arrow in an equation indicates the direction of the reaction.

$$\mathbf{C + O_2 \rightarrow CO_2}$$

3. **Chemical equations must be balanced.**
   A ***chemical equation*** must reflect the Law of Conservation of Mass, so each side of an equation must have the same number of atoms of each element.

- An equation is balanced by changing the number of molecules of reactants and products represented. This is done by adding coefficients in front of some of the chemical formulas as shown in the equations below:

$\mathbf{N_2 + H_2 \rightarrow NH_3}$	$\mathbf{N_2 + 3H_2 \rightarrow 2NH_3}$
Unbalanced Equation	**Balanced Equation**

- When balancing an equation, ***subscripts*** in the chemical formulas of the reactants and products cannot be changed. Changing a subscript changes the substance represented by the formula. Therefore, equations must be balanced by changing ***coefficients***, which changes only the amounts of the reactants and products represented by the equation.

SECTION 3 (PP. 214-221): CHEMICAL REACTIONS INVOLVE ENERGY CHANGES.

Georgia Standards: S8P2 – *Students will be familiar with the forms and transformations of energy;* S8CS4b - *Use appropriate tools and units for measuring objects and/or substances.*

1. **Chemical reactions release and absorb energy.**
   Chemical reactions break the chemical bonds in reactants and make new bonds in the products. Breaking bonds requires energy; forming bonds releases energy. The energy in chemical bonds is called ***bond energy***.
   - If more energy is released when the bonds in the products form, than is used to break the bonds in the reactants, energy is released by the ***exothermic reaction***.
   - If more energy is needed to break the bonds in reactants, than is released when the bonds in the products form, energy is absorbed by the ***endothermic reaction***.

2. **Exothermic reactions release energy.**
   In exothermic reactions, the reactants have lower bond energies than the products, so energy is released, often as heat and light. All common ***combustion reactions*** are exothermic.

3. **Endothermic reactions absorb energy.**
   In ***endothermic reactions***, the reactants have higher bond energies than the products, so energy is absorbed.

4. **Exothermic and endothermic reactions work together to supply energy.**
   Endothermic and exothermic reactions can form a cycle. For example, the energy stored by the series of endothermic reactions in photosynthesis can be released by exothermic reactions such as combustion.

SECTION 4 (PP. 222-227): LIFE AND INDUSTRY DEPEND ON CHEMICAL REACTIONS.

Georgia Standards: S8P2 – *Students will be familiar with the forms and transformations of energy;* S8CS4c – *Learn and use standard safety practices when conducting scientific investigations.*

1. **Living things require chemical reactions.**
   Photosynthesis is an endothermic process. During photosynthesis, plants absorb energy from sunlight and store this energy in the chemical bonds of sugars. These sugars are broken down during the exothermic reactions of ***respiration***, the process that produces energy for living organisms. The process of photosynthesis and respiration are essentially the reverse of one another.

   Photosynthesis: $6CO_2 + 6H_2O + \text{energy} \rightarrow C_6H_{12}O_6 + 6O_2$

   Respiration: $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{energy}$

   Most reactions that take place in living organisms use ***enzymes*** (*catalysts*) that cause reactions to take place at the relatively low temperatures of living organisms.

2. **Chemical reactions are used in technology.**
   Combustion engines use gasoline in a chemical reaction that releases energy. Catalytic converters are technological devices that remove unwanted pollutants from the burning of gasoline in automobile engines. These devices use metal as catalysts. The metal catalysts in a catalytic converter (which include platinum, palladium, and rhodium) allow reactions between exhaust gases to occur. These reactions change the exhaust gases into gases that are typical parts of Earth's atmosphere. These include oxygen, nitrogen, water vapor, and carbon dioxide.

3. **Industry uses chemical reactions to make useful products.**
   The electronics industry produces silicon for microchips by refining SiO_2 (quartz) into pure silicon. Silicon treated with photoresist and light produces miniature electronic circuits.