Ch 7 Chemical Reactions

7.1 Chemical Reactions Alter Arrangements of Atoms

Atoms interact in chemical reactions

Substances change in 2 ways

1. Physical changes—substance, itself, does not change but its appearance or properties may
2. Chemical changes—substance changes into a *different* substance

*chemical reactions rearrange atoms

*bonds are broken in reactants

& new bonds form in products

Evidence of chemical changes

1. Temperature change
2. Formation of a precipitate (solid forms after 2 liquids are mixed), gases, fumes, or odors
3. Burning
4. Rusting
5. Cooking

Chemical Reactions Can Be Classified

5 Types

1. Synthesis—combines 2 or more simpler reactants to form a new, more complex product

$$2\ K + Br_2 \rightarrow 2\ KBr$$

2. Decomposition—breaks a reactant into 2 or more simpler products

$$2\ NaCl \rightarrow 2\ Na + Cl_2$$

3. Combustion—always involves oxygen; the other reactant usually contains C & H; something burns

$$CH_4 + 2\ O_2 \rightarrow CO_2 + 2\ H_2O$$

4. Single replacement—1 switch takes place

$Zn + CuCl_2 \rightarrow ZnCl_2 + Cu$

5. Double replacement—2 switches take place

$AgNO_3 + KCl \rightarrow AgCl + KNO_3$

Rates of Chemical Reactions can Vary

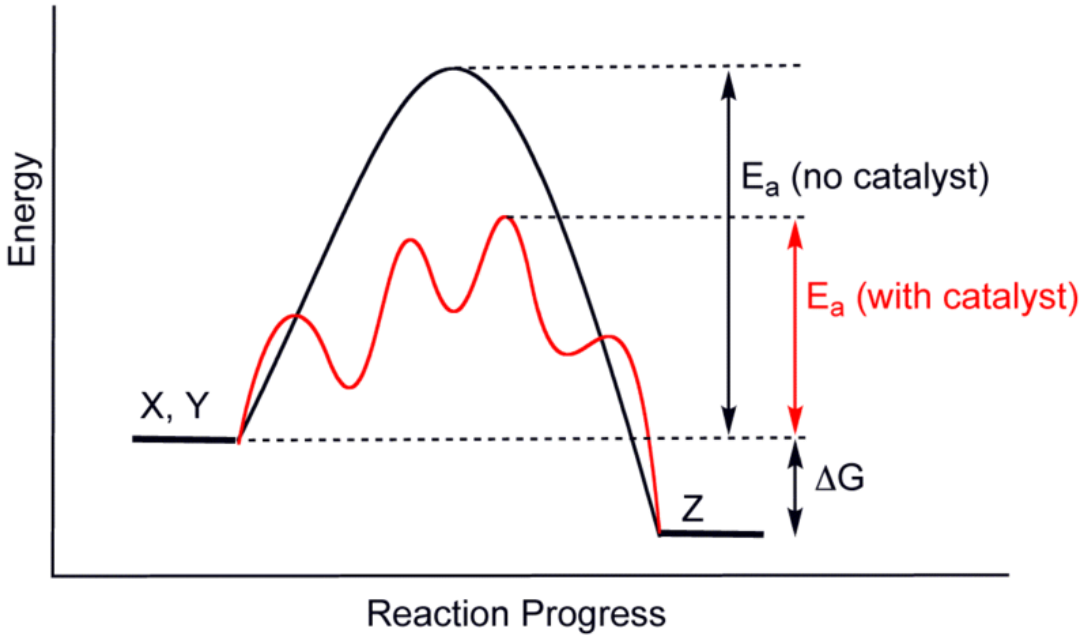
4 factors can change the rate of a chemical reaction:

1. Concentration of reactants
2. Surface area of reactants
3. Temperature of the reaction mixture
4. Presence of a catalyst

Catalyst

1. Speeds up a reaction but is *not consumed* during the reaction
2. Decreases the energy needed to start a reaction
3. Increases the reaction rate

*Enzymes are catalysts



7.2 Masses of reactants & products are *EQUAL*

Law of Conservation of Matter

Matter is neither created or destroyed in a chemical reaction but changes from one form to another

- Careful observations led to the discovery of the conservation of mass
  - Antoine Lavoiser's experiments showed that
    mass of reactants = mass of products
  - Mass is neither created or destroyed in a chemical reaction

Chemical reactions can be described by chemical equations

- The reactants & products are represented by chemical formulas

$AgNO_3$ (*silver nitrate*)

- The direction of the reaction is indicated by an arrow

$$2\ K + Br_2 \rightarrow 2\ KBr$$

Chemical equations must be *BALANCED*

- Equations must reflect the law of conservation of mass
- The #s of each element must be the same on both sides of the arrow
- *Subscripts* may NOT be changed
- *Coefficients* MAY be placed in front of a compound's chemical formula

$2\ NaCl \rightarrow 2\ Na + Cl_2$

Diatomic Molecules

These molecules are always covalently bonded in pairs

Hydrogen
Nitrogen
Oxygen
Fluorine
Chlorine

Bromine
Iodine

Some practice problems:

- 1. __NaCl + __BeF_2 --> __NaF + __$BeCl_2$
- 2. __$FeCl_3$ + __$Be_3(PO_4)_2$ --> __$BeCl_2$ + __$FePO_4$
- 3. __$AgNO_3$ + __LiOH --> __AgOH + __$LiNO_3$
- 4. __CH_4 + __O_2 --> __CO_2 + __H_2O
- 5. __Mg + __Mn_2O_3 --> __MgO + __Mn

Solutions for the practice problems:

1. $2\ NaCl + BeF_2 \rightarrow 2\ NaF + BeCl_2$

2. $2\ FeCl_3 + Be_3(PO_4)_2 \rightarrow 3\ BeCl_2 + 2\ FePO_4$

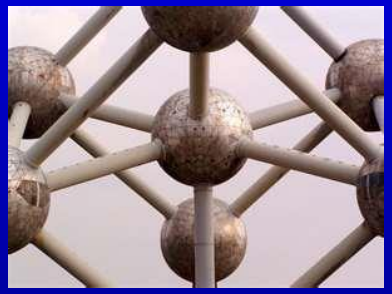
3. $AgNO_3 + LiOH \rightarrow AgOH + LiNO_3$

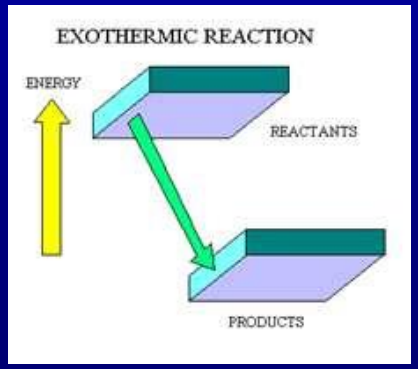
4. $CH_4 + 2\ O_2 \rightarrow CO_2 + 2\ H_2O$

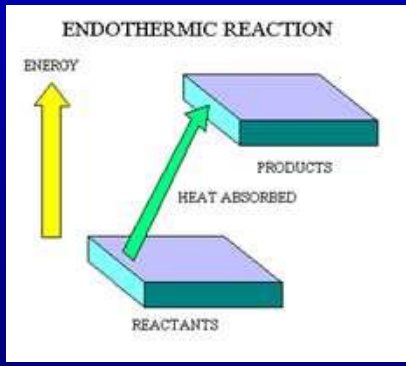
5. $3\ Mg + Mn_2O_3 \rightarrow 3\ MgO + 2\ Mn$

7.3 Chemical reactions involve energy changes

- Chemical reactions release or absorb energy
- Breaking & reforming atomic bonds <u>requires energy</u>
- <u>Bond energy</u>—energy in chemical bonds
  - Exothermic reactions
  - Endothermic reactions







Exothermic Reactions

- Bond energy is higher in the products
- Release energy, usually as heat & light
- All *combustion* reactions are exothermic

burning magnesium

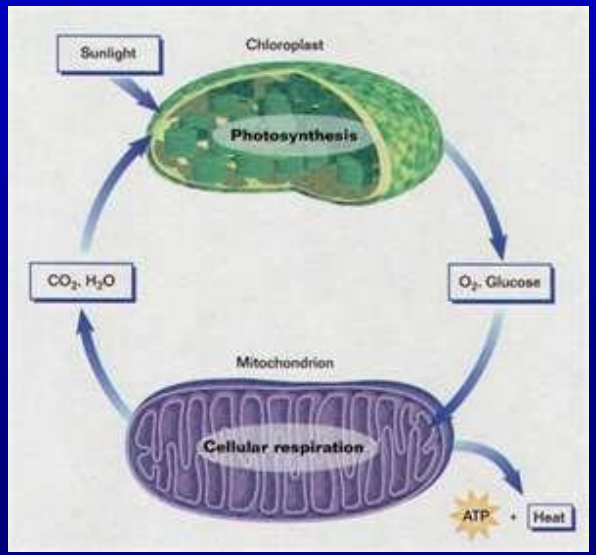
Endothermic Reactions

- Bond energy is higher in the reactants
- Temperature decreases & the substances feel cold to the touch

Exothermic & Endothermic reactions work together to supply energy

Can form a *cycle*

Example: Photosynthesis & Cellular Respiration (opposite reactions)…



$6CO_2 + 6H_2O + \text{Energy} \rightarrow C_6H_{12}O_6 + 6O_2$

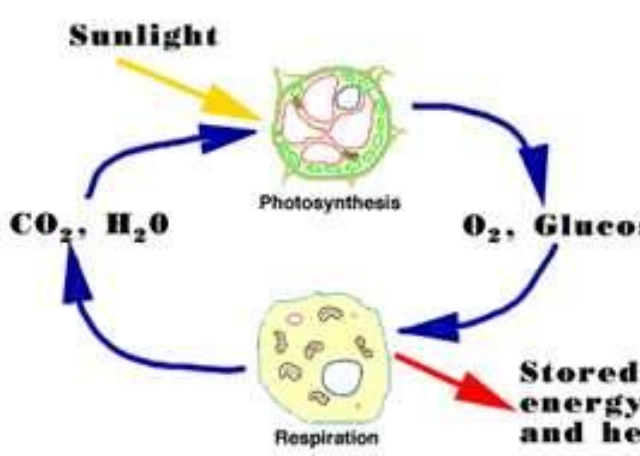
(photosynthsis, endothermic)

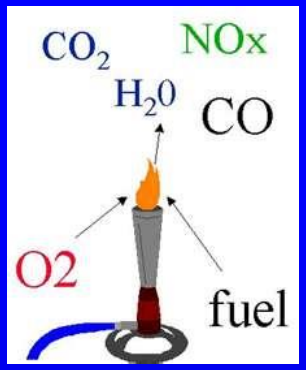
$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{Energy}$

(cellular respiration, exothermic)

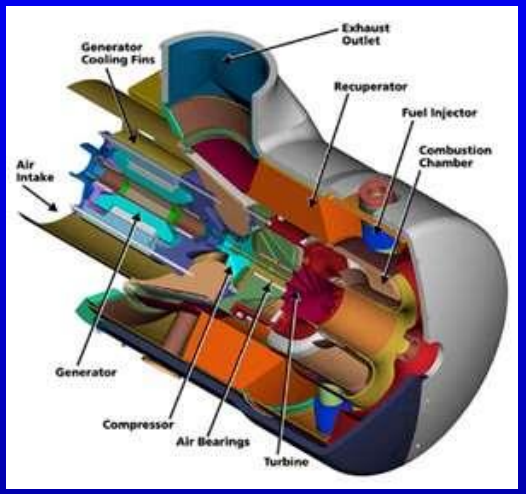
7.4 Life & Industry depend on chemical reactions

- Photosynthesis is endothermic
  - Plants change light energy into chemical energy (glucose)
  - -Bond energy is greater in the reactants
- Cellular respiration is exothermic
  - Sugars are broken down
  - Bond energy is greater in the products





Chemical reactions are used in technology



- Combustion engines use gasoline in a chemical reaction that releases energy
- Catalytic converters remove unwanted pollutants from the burning of gasoline in automobile engines
  - Metals are used as catalysts that change exhaust gases like NO & CO into carbon dioxide, & water vapor

Industry uses chemical reactions to make useful products

- Electronics industry produces silicon for microchips
- Silicon treated with photoresist are used to make small circuits

photoresist = light sensitive material used in photoengraving