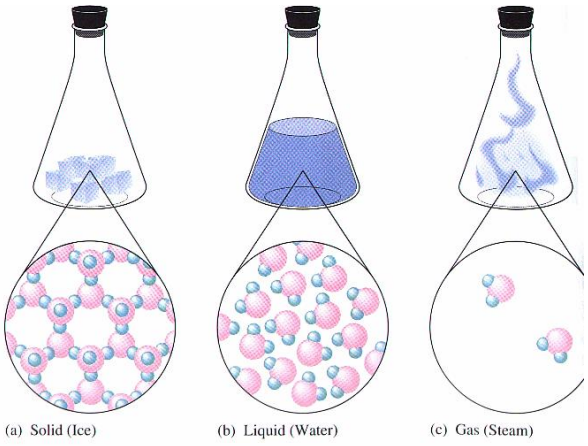
PHYSICAL & CHEMICAL CHANGES

- The ***characteristics*** of a substance are called its ***properties***.

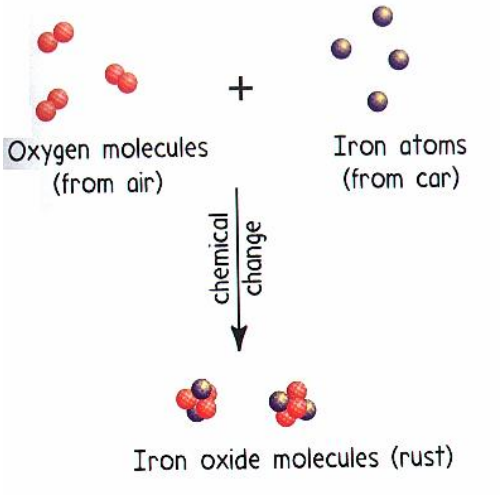
- ***Physical properties*** are those that describe the matter ***without changing its composition***. Examples are density, color, melting and boiling points, and electrical conductivity.

- ***Chemical properties*** are those that describe how matter behaves in combination with other matter, and involve ***change in its composition***. Examples are flammability, corrosion, and reactivity with acids.

- ***Changes in physical properties*** of matter that do not involve change in its composition are ***called physical changes***. Examples are melting, evaporation and other phase changes. Physical changes are ***easily reversible***.



- A change that ***alters the chemical composition*** of matter, and ***forms new substance*** is called a ***chemical change***. Examples are burning, rusting, and reaction with acids. Chemical changes are ***not easily reversible***, and are commonly called ***chemical reactions***.



Examples:

Identify each of the following properties as physical or chemical:

1. Oxygen is a gas
2. Helium is un-reactive
3. Water has high specific heat
4. Gasoline is flammable
5. Sodium is soft & shiny

Identify each of the following changes as physical or chemical:

1. Cooking food
2. Mixing sugar in tea
3. Carving wood
4. Burning gas
5. Food molding

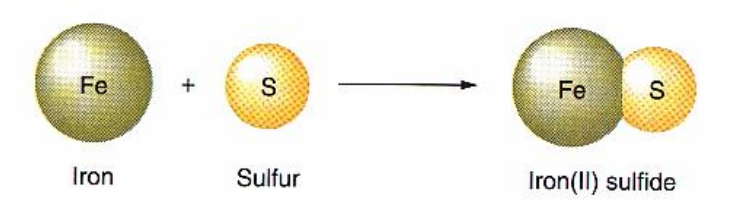
CHEMICAL REACTIONS

- A ***chemical equation*** is a shorthand notation for describing a ***chemical reaction***. It includes ***reactants*** and ***products*** and has the general form

$$\underset{\text{Reactants}}{A + B} \xrightarrow{\text{(yields)}} \underset{\text{Products}}{C + D}$$

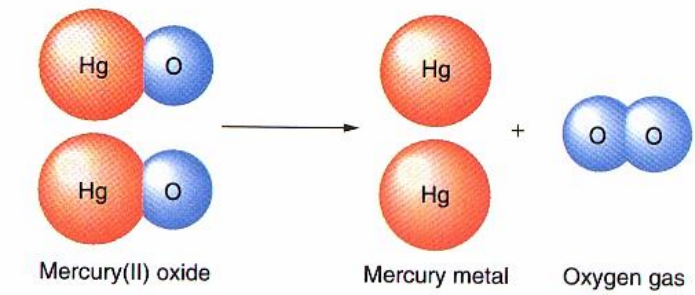
- Chemical reactions are classified into ***four types***:

1. *Synthesis or combination* (A + B → AB)



- Two ***elements or compounds*** combine to form another compound.

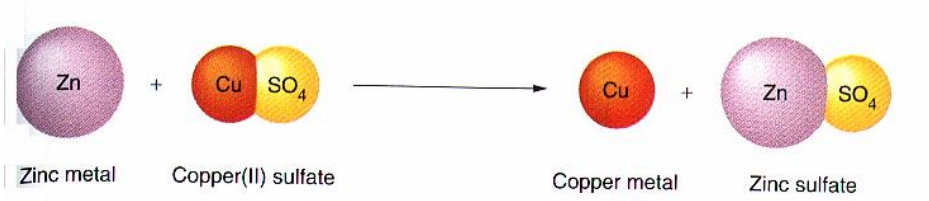
2. *Decomposition* (AB → A + B)



- A compound breaks up to form ***elements or simpler compound***.

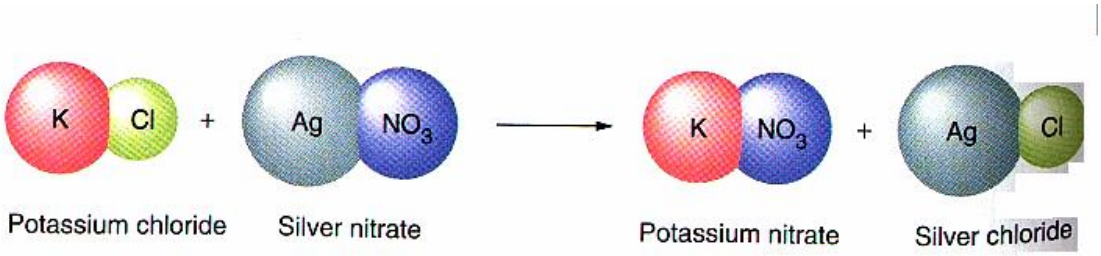
CHEMICAL REACTIONS

3. *Single Replacement* (A + BC → B + AC)



- A ***more reactive element*** replaces a ***less reactive element*** in a compound.

4. *Double Replacement* (AB + CD → AD + BC)



- ***Two compounds*** interact to form two ***new compounds***.

Examples:

Classify each of the reactions below:

1. $Mg + CuCl_2 \rightarrow MgCl_2 + Cu$ _____

2. $CaCO_3 \rightarrow CaO + CO_2$ _____

3. $2\ HCl + Ca(OH)_2 \rightarrow CaCl_2 + H_2O$ _____

4. $4\ Fe + 3\ O_2 \rightarrow 2\ Fe_2O_3$ _____

BALANCING CHEMICAL EQUATIONS

- A ***balanced equation*** contains the ***same number of atoms*** on each side of the equation, because no atoms can be gained or lost during a chemical reaction.

- To balance a chemical equation, remember that ***coefficients can be changed***, but ***not subscripts*** of a correct formula.

The general procedure for balancing equations is:

1. ***Write the unbalanced equation***
   - Make sure the formula for each substance is correct

$$C + SO_2 \rightarrow CS_2 + CO$$

2. ***Balance by inspection***
   - Count and compare each element on both sides of the equation.

1 C	≠	2 C
1 S	≠	2 S
2 O	≠	1 O

- Balance elements that appear only in one substance first.

Balance S : $\_\_\_C + \_\_\_SO_2 \rightarrow \_\_\_CS_2 + \_\_\_CO$

Balance O : $\_\_\_C + \_\_\_SO_2 \rightarrow \_\_\_CS_2 + \_\_\_CO$

Balance C : $\_\_\_C + \_\_\_SO_2 \rightarrow \_\_\_CS_2 + \_\_\_CO$

Examples:

1) $NaN_3 \rightarrow Na + N_2$

Balance N : $\_\_\_\ NaN_3 \rightarrow \_\_\_Na + \_\_\_\ N_2$

Balance Na : $\_\_\_\ NaN_3 \rightarrow \_\_\_\ Na + \_\_\_\ N_2$

2) $C_3H_8 + O_2 \rightarrow CO_2 + H_2O$

Balance C : $\_\_\_C_3H_8 + \_\_\_O_2 \rightarrow \_\_\_\ CO_2 + \_\_\_H_2O$

Balance H : $\_\_\_C_3H_8 + \_\_\_O_2 \rightarrow \_\_\_\ CO_2 + \_\_\_H_2O$

Balance O : $\_\_\_C_3H_8 + \_\_\_O_2 \rightarrow \_\_\_\ CO_2 + \_\_\_H_2O$

3) $Al + H_2SO_4 \rightarrow Al_2(SO_4)_3 + H_2$

Balance S : $\_\_\_Al + \_\_\_H_2SO_4 \rightarrow \_\_\_Al_2(SO_4)_3 + \_\_\_H_2$

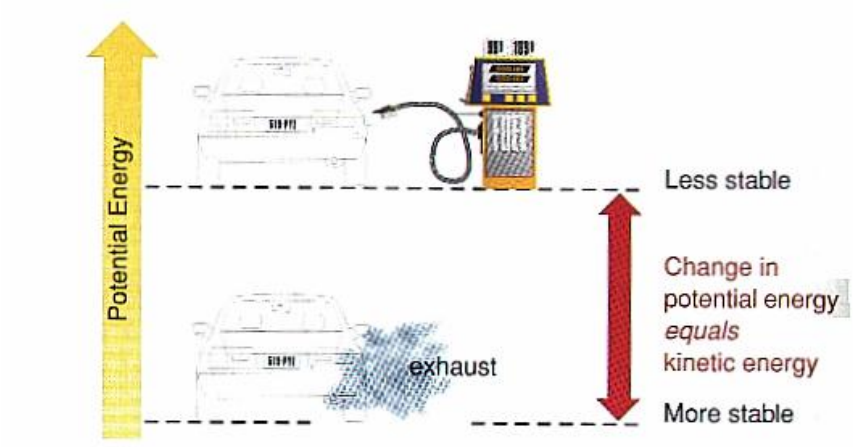
Balance O: $\_\_\_Al + \_\_\_H_2SO_4 \rightarrow \_\_\_Al_2(SO_4)_3 + \_\_\_H_2$

Balance H : $\_\_\_Al + \_\_\_H_2SO_4 \rightarrow \_\_\_Al_2(SO_4)_3 + \_\_\_H_2$

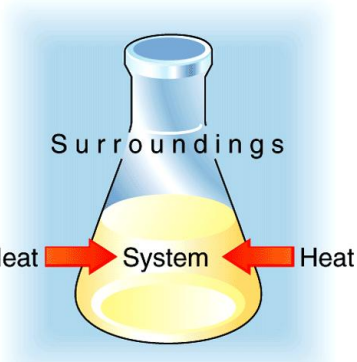
Balance Al : $\_\_\_Al + \_\_\_H_2SO_4 \rightarrow \_\_\_Al_2(SO_4)_3 + \_\_\_H_2$

ENERGY IN CHEMICAL REACTIONS

- In all ***chemical changes***, matter either ***absorbs or releases energy***.
- ***Higher energy*** systems are ***less stable*** than lower energy systems.

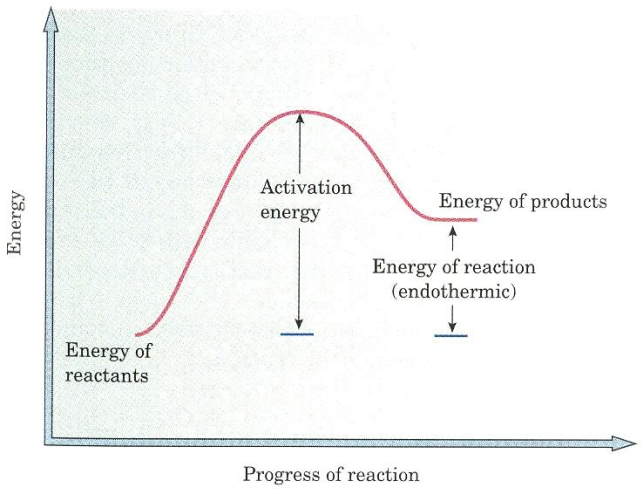


- When ***energy is released*** during a chemical reaction, it is said to be ***exothermic***.
- Exothermic reactions ***heat up*** the surroundings. An example is the burning of gasoline.
- When ***energy is absorbed*** during a chemical reaction, it is said to be ***endothermic***.
- Endothermic reactions cool the surroundings. An example is athletic ice packs.



RATES OF REACTIONS

- The ***speed*** at which a chemical reaction occurs is called the ***rate of reaction***.
- The ***rate*** of a reaction can be ***affected*** by changes in ***temperature***, the ***concentration of reactants***, ***surface area***, and the addition of ***catalyst***.
- The ***minimum energy*** required for a reaction to occur is called ***activation energy***.



- Addition of a ***catalyst increases the rate*** of the reaction by ***decreasing the activation energy*** for the reaction. As a result, more molecules ***possess the required energy*** and form product successfully.