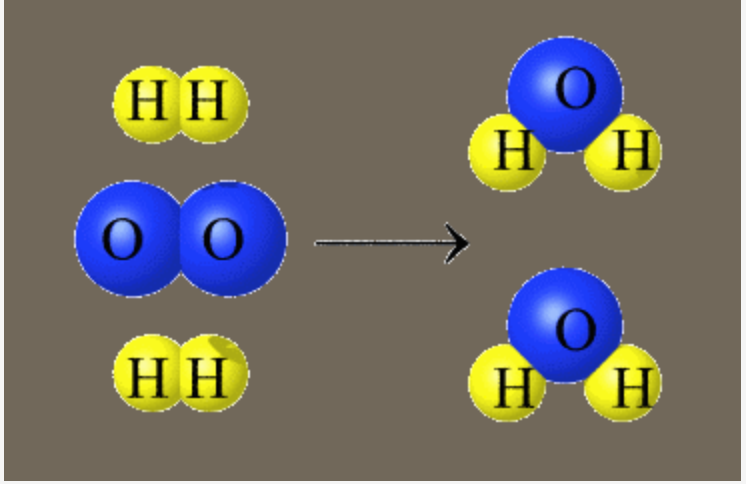
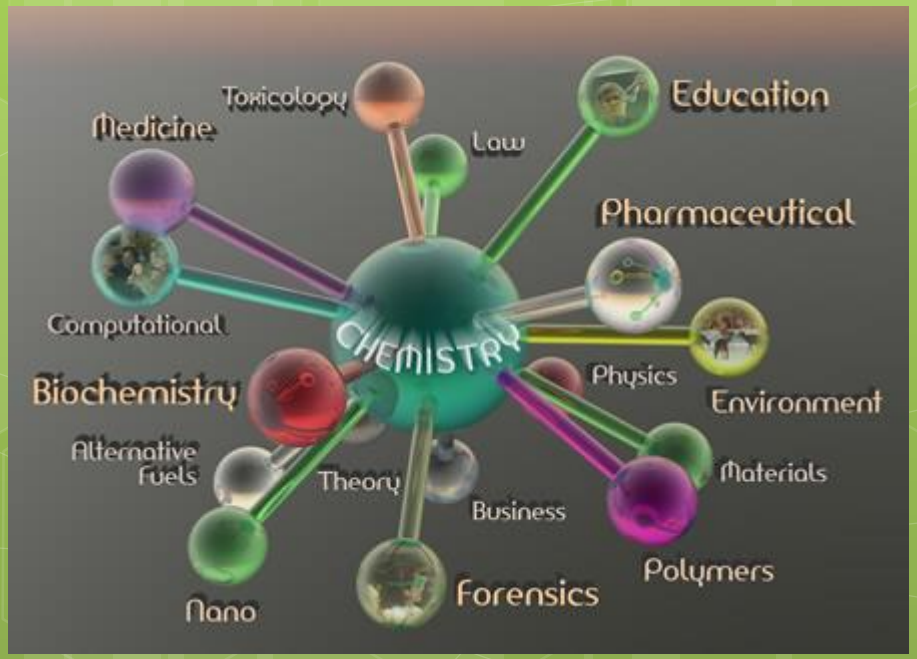


Chapter 11: Chemical Reactions

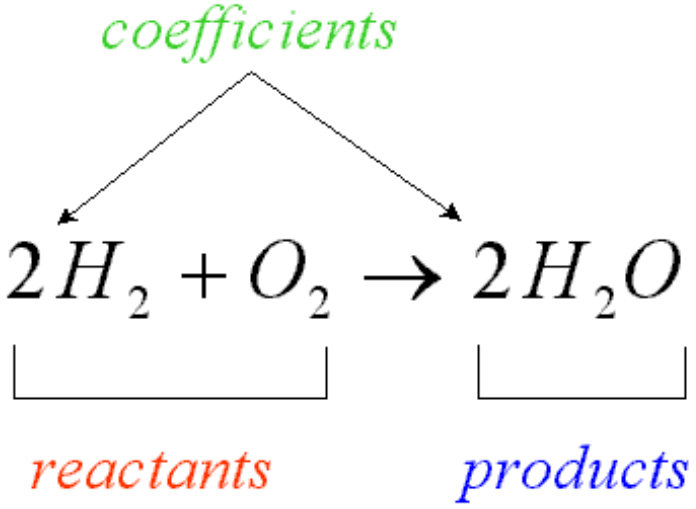
By Jennie Borders



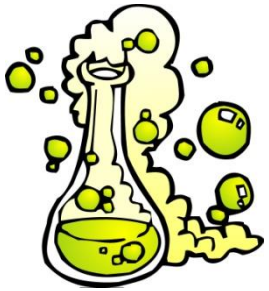
Section 11.1 – Describing Chemical Reactions

- The reactants are written on the left and the products on the right.
- The arrow that separates them is called yield.

Reactants → Products



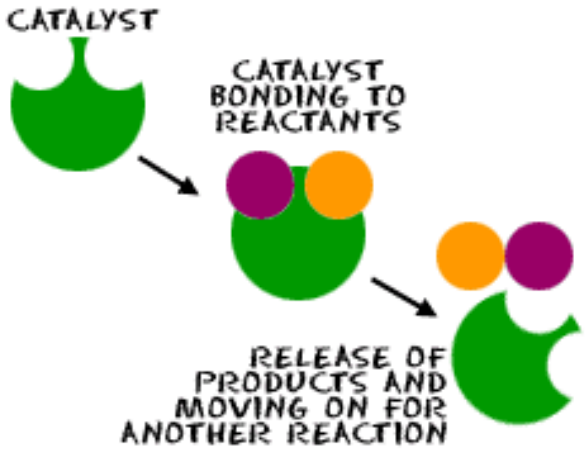
Symbols in Equations

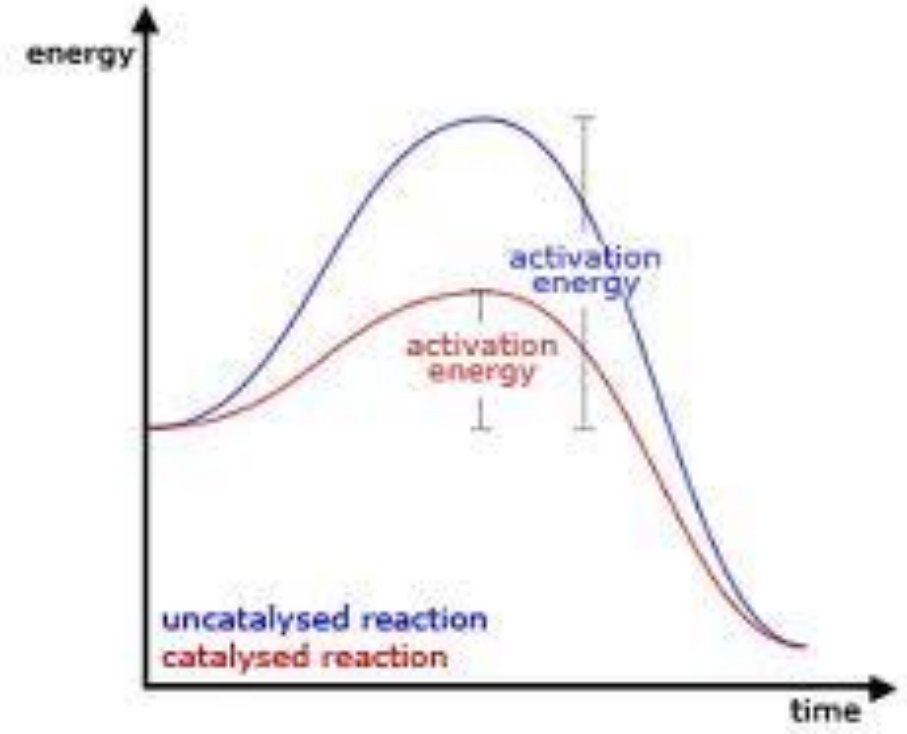


Symbol	Meaning
→	yields
⇆	reversible reaction
(s)	solid
(l)	liquid
(g)	gas
(aq)	aqueous
$\xrightarrow{Pt}$	catalyst
$\xrightarrow{\Delta}$	heat

Catalyst

- A catalyst is a substance that speeds up a reaction but is not used up in the reaction.





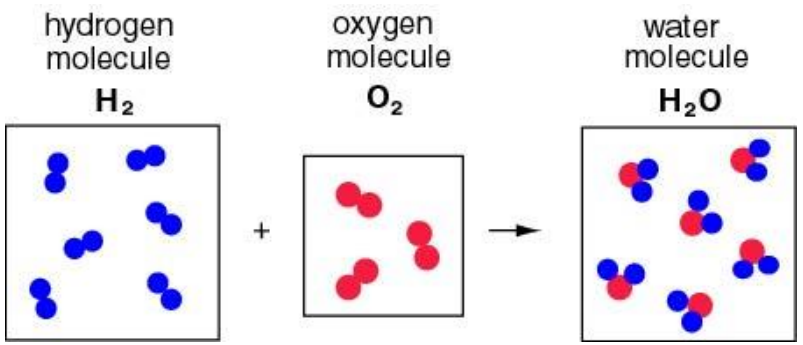
Word Equations

Ex: chemical equation

$$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(l)}$$

Ex: word equation

Hydrogen gas and oxygen gas react to form liquid water.



Sample Problem #1

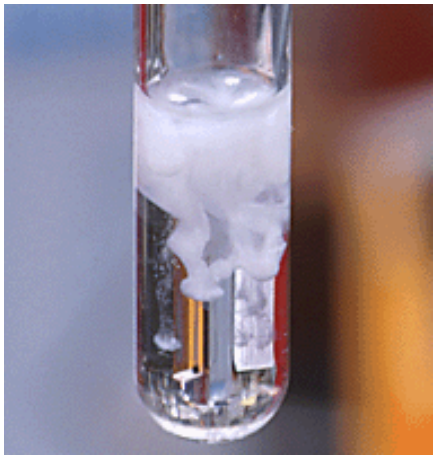
- Write a sentence that describes this chemical reaction:

$$Na_{(s)} + H_2O_{(l)} \rightarrow NaOH_{(aq)} + H_{2(g)}$$

Practice Problem #1

- Write a sentence that describes this reaction:

$$H_2SO_{4(aq)} + BaCl_{2(aq)} \rightarrow BaSO_{4(s)} + HCl_{(aq)}$$

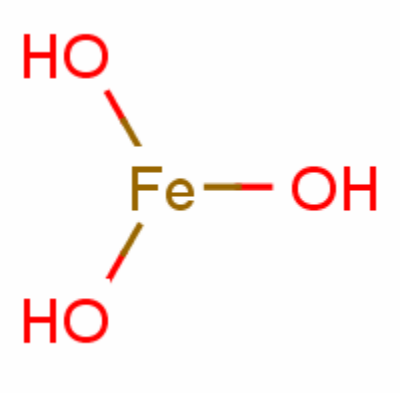


Practice Problem #2

- Write the chemical equation for the following reaction:

  Solid iron(III)hydroxide is heated to form solid iron(III)oxide and water

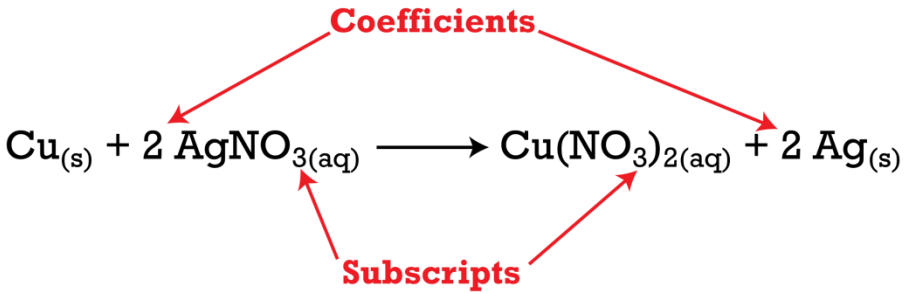
Δ



Balancing Chemical Equations

$$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(l)}$$

- Coefficients are the numbers in front of a chemical formula.
- Subscripts are numbers that show the number of atoms in a compound.
- When balancing reactions, you can only change the coefficients, **not** the subscripts.



Balancing Chemical Equations

- To balance a chemical equation, you add coefficients to the substances so that both sides of the equation contain equal numbers and types of atoms.
- Equation follows the law of conservation of mass.

Rules for Balancing Equations

- Balance hydrogen and oxygen last.
- Count a polyatomic ion as a single unit if it appears unchanged on both sides of the equation.
- If you end up with an odd number, you can double all of the coefficients.
- Make sure to reduce the coefficients to the lowest whole-number ratio.
- A coefficient of one is understood and does not need to be written.

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

C=1		C=1
H=4	=	H=4
O=4		O=4

Sample Problems

Balance the following equations:

1. ___H_2 + ___O_2 → ___H_2O

   2 H_2 + ___O_2 → 2 H_2O

2. ___$AgNO_3$ + ___H_2S → ___Ag_2S + ___HNO_3

   2 $AgNO_3$ + ___H_2S → ___Ag_2S + 2 HNO_3

3. ___$Zn(OH)_2$ + ___H_3PO_4 → ___$Zn_3(PO_4)_2$ + ___H_2O

   3 $Zn(OH)_2$ + 2 H_3PO_4 → ___$Zn_3(PO_4)_2$ + 6 H_2O

Practice Problems

1. ___$FeCl_3$ + ___NaOH → ___$Fe(OH)_3$ + ___NaCl

   ___$FeCl_3$ + 3 NaOH → ___$Fe(OH)_3$ + 3 NaCl

2. ___CS_2 + ___Cl_2 → ___CCl_4 + ___S_2Cl_2

   ___CS_2 + 3 Cl_2 → ___CCl_4 + ___S_2Cl_2

3. ___C_2H_6 + ___O_2 → ___CO_2 + ___H_2O

   2 C_2H_6 + 7 O_2 → 4 CO_2 + 6 H_2O

Section 11.1 Assessment

3. Balance the following equations:

a. $\_2\_ SO_2 + \_\_\_ O_2 \rightarrow \_2\_ SO_3$

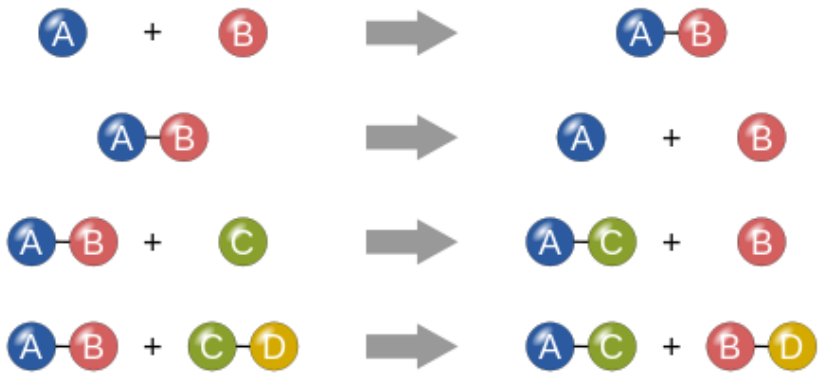
b. $\_\_\_ Fe_2O_3 + \_3\_ H_2 \rightarrow \_2\_ Fe + \_3\_ H_2O$

c. $\_4\_ P + \_5\_ O_2 \rightarrow \_\_\_ P_4O_{10}$

d. $\_2\_ Al + \_\_\_ N_2 \rightarrow \_2\_ AlN$

Section 11.2 – Types of Chemical Reactions

- The five general types of reactions are synthesis, decomposition, single displacement, double displacement, and combustion.

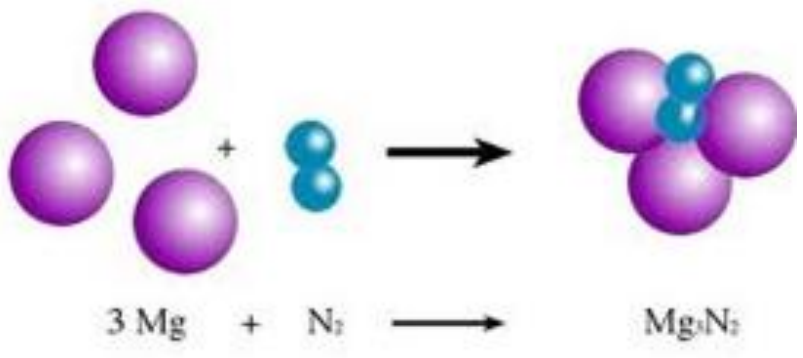


Synthesis Reactions

- In a synthesis reaction, two or more substances react to form one product.
- Generic Reaction:

$$A + B \rightarrow AB$$

- Demo: Magnesium Strip



Predicting Products

- Predict the products for the following reactions:

1. $Cu + S \rightarrow$ (Hint: copper is +1)

   $2Cu + S \rightarrow Cu_2S$

2. $Be + O_2 \rightarrow$

   $2Be + O_2 \rightarrow 2BeO$

3. $Fe + S \rightarrow$ (Hint: iron is +3)

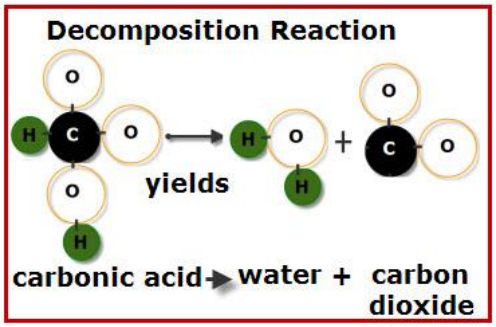
   $2Fe + 3S \rightarrow Fe_2S_3$

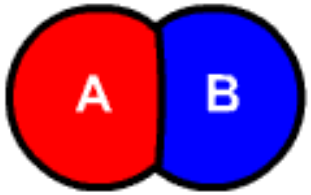
Decomposition Reactions

- A decomposition reaction occurs when a single reactant breaks down into two or more products.
- Generic Reaction:

$$AB \rightarrow A + B$$

- Demo: Hydrogen peroxide





Predicting Products

- Predict the products for the following reactions:

1. $H_2O \rightarrow$

$2H_2O \rightarrow 2H_2 + O_2$

2. $HI \rightarrow$

$2HI \rightarrow H_2 + I_2$

3. $NH_3 \rightarrow$

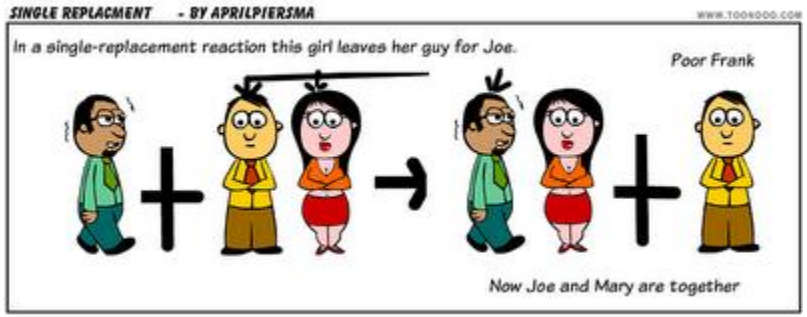
$2NH_3 \rightarrow N_2 + 3H_2$

Single Displacement Reactions

- A single displacement reaction occurs when one element replaces a second element in a compound.
- Generic Reaction:

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

- Demo: Silver Nitrate and Copper



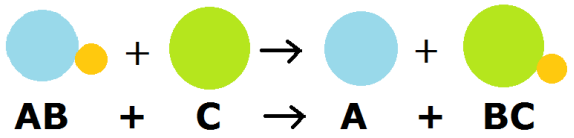


Figure 2.5

Predicting Products

- Predict the products for the following reactions:

1. $Br_2 + NaI \rightarrow$

$$Br_2 + 2NaI \rightarrow 2NaBr + I_2$$

2. $Fe + Pb(NO_3)_2 \rightarrow$ (Hint: iron is +3)

$$2Fe + 3Pb(NO_3)_2 \rightarrow 2Fe(NO_3)_3 + 3Pb$$

3. $Zn + H_2SO_4 \rightarrow$ (Hint: zinc is +2)

$$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$$

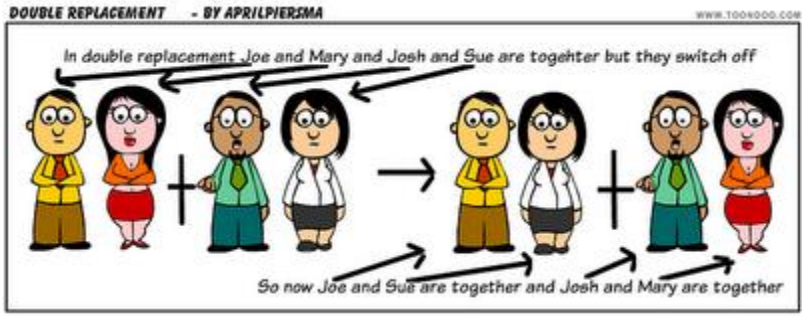
Double Displacement Reactions

- A <u>double displacement</u> reaction involves the exchange of <u>two positive ions</u> between two compounds.
- Generic Reaction:

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

- Actual Example:

$$2NaCN + H_2SO_4 \rightarrow 2HCN + Na_2SO_4$$



Predicting Products

- Predict the products for the following reactions:

1. $CaBr_2 + AgNO_3 \rightarrow$

   $CaBr_2 + 2AgNO_3 \rightarrow 2AgBr + Ca(NO_3)_2$

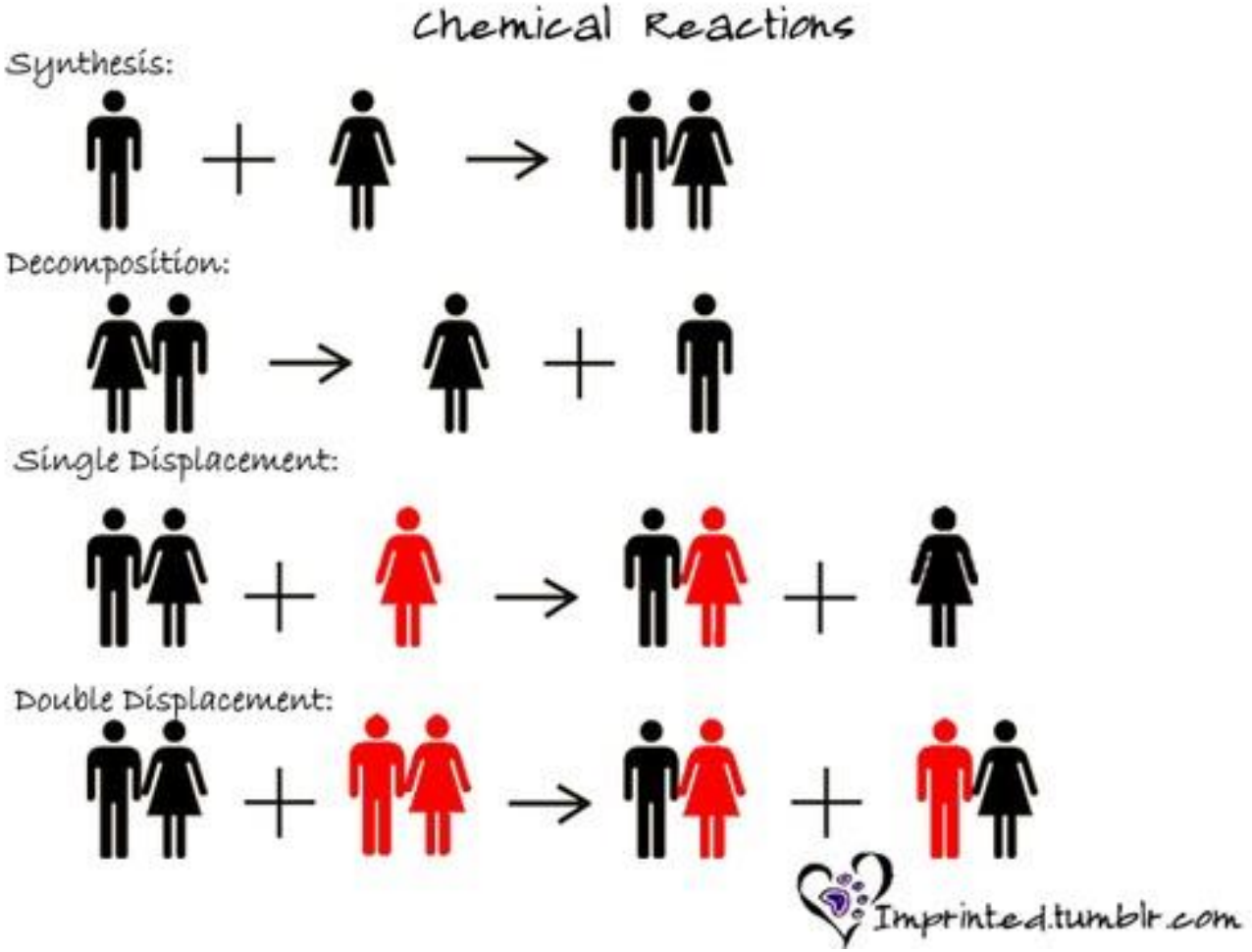
2. $FeS + HCl \rightarrow$

   $FeS + 2HCl \rightarrow FeCl_2 + H_2S$

3. $NaOH + Fe(NO_3)_3 \rightarrow$

   $3NaOH + Fe(NO_3)_3 \rightarrow Fe(OH)_3 + 3NaNO_3$

Relationships and Reactions



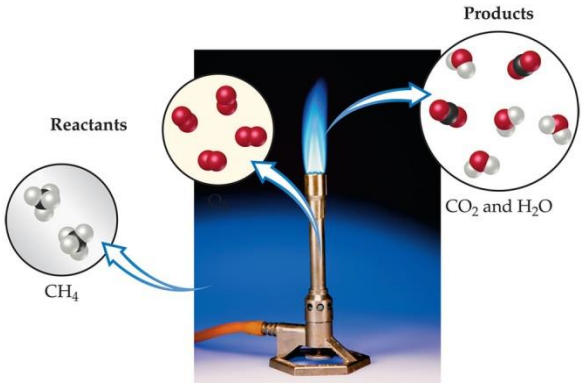
Combustion Reactions

- A combustion reaction occurs when a substance burns in oxygen and produces a lot of heat and light.
- Generic Reaction:

$$C_xH_y + O_2 \rightarrow CO_2 + H_2O$$

- Actual Example:

$$2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$$



Predicting Products

- Predict the products for the following reactions:

1. $C_6H_6 + O_2 \rightarrow$

   $2C_6H_6 + 15O_2 \rightarrow 12CO_2 + 6H_2O$

2. $C_7H_{16} + O_2 \rightarrow$

   $C_7H_{16} + 11O_2 \rightarrow 7CO_2 + 8H_2O$

3. $C_6H_{12}O_6 + O_2 \rightarrow$

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