
Chemical
Reactions

Indicators of chemical reactions

- Emission of light or heat

- Formation of a gas

- Formation of a precipitate

- Color change

- Emission of odor

All chemical reactions:

- have two parts
- Reactants - the substances you start with
- Products- the substances you end up with
- The reactants turn into the products.
- Reactants → Products

Summary of Symbols

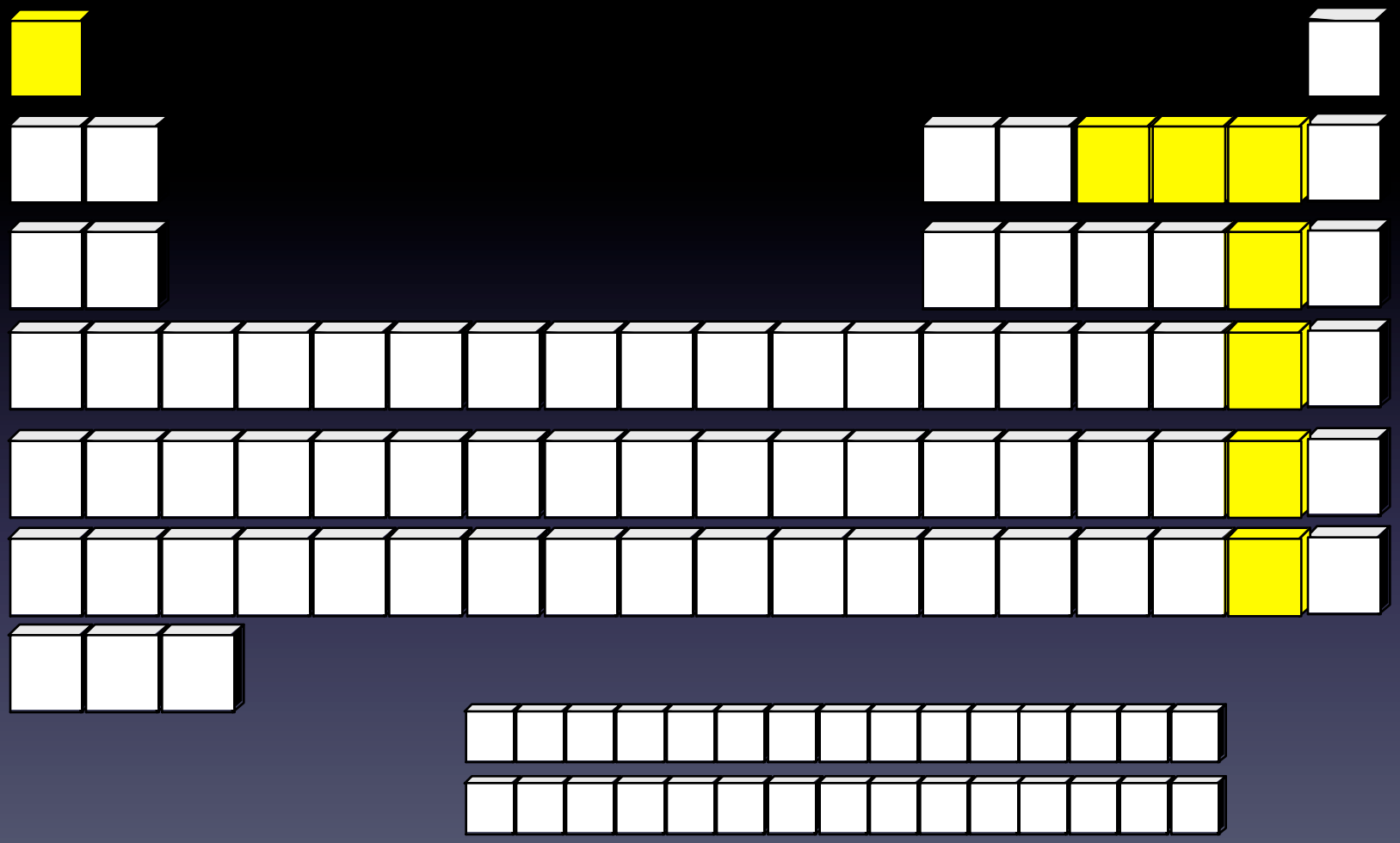
Reactants and Products Symbol	Meaning
(*s*) or (*cr*)	solid or crystal
(*l*)	liquid
(*g*)	gas
(*aq*)	in aqueous solution (dissolved in water)
$\downarrow$	solid precipitate product forms
$\uparrow$	gaseous product forms

Reaction Conditions Symbol	Meaning
$\longrightarrow$	"produces" or "yields," indicating result of reaction
$\rightleftharpoons$	reaction in which products can re-form into reactants; final result is a mixture of products and reactants
$\xrightarrow{\Delta}$ or $\xrightarrow{\text{heat}}$	reactants are heated
$\xrightarrow{1.0 \times 10^8\ \text{kPa}}$	pressure at which reaction is carried out
$\xrightarrow{0°\text{C}}$	temperature at which reaction is carried out
$\xrightarrow{\text{Pd}}$	chemical formula of a catalyst added to speed up a reaction
$\xrightarrow[e^-]{}$	electrolysis

Diatomic elements

- There are 8 elements that never want to be alone.
- They form diatomic molecules.
- H_2 , N_2 , O_2 , F_2 , Cl_2 , Br_2 , I_2 , and At_2
- The –ogens and the –ines
- 1 + 7 pattern on the periodic table

Element	Symbol	Molecular formula	Physical state at room temperature
Hydrogen	H	H_2	gas
Nitrogen	N	N_2	gas
Oxygen	O	O_2	gas
Fluorine	F	F_2	gas
Chlorine	Cl	Cl_2	gas
Bromine	Br	Br_2	liquid
Iodine	I	I_2	solid

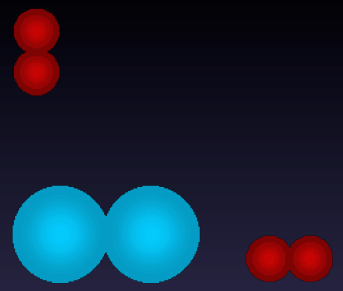


Types of Reactions

- There are millions of reactions.
- Can't remember them all
- Fall into several categories.
- We will learn 6 types.
- We will be able to predict the products.
- For some we will be able to predict whether they will happen at all.
- We will recognize them by the reactants

Synthesis Reactions

- Also called combination reactions
- 2 elements, or compounds combine to make one compound.



- A + B → AB
- $Na_{(s)} + Cl_{2\,(g)} \rightarrow NaCl_{(s)}$
- $Ca_{(s)} + O_{2\,(g)} \rightarrow CaO_{(s)}$
- $SO_{3\,(s)} + H_2O_{(l)} \rightarrow H_2SO_{4\,(s)}$
- We can predict the products if they are two elements.
- $Mg_{(s)} + N_{2\,(g)} \rightarrow Mg_3N_{2\,(s)}$

Decomposition Reactions

- decompose = fall apart
- one compound (reactant) falls apart into two or more elements or compounds.
- Usually requires energy
- **AB → A + B**
- $NaCl \xrightarrow{\text{electricity}} Na + Cl_2$
- $CaCO_3 \xrightarrow{\Delta} CaO + CO_2$

Decomposition Reactions

- Can predict the products if it is a binary compound
- Made up of only two elements
- Falls apart into its elements
- $H_2O \xrightarrow{\text{electricity}} H_{2\,(g)} + O_{2\,(g)}$
- $HgO \xrightarrow{\Delta} Hg_{(s)} + O_{2\,(g)}$

Decomposition Reactions

- If the compound has more than two elements you must be given one of the products
- The other product will be from the missing pieces
- $NiCO_{3\,(aq)} \xrightarrow{\Delta} CO_{2\,(g)} + Ni_{(s)}$
- $H_2CO_{3(aq)} \rightarrow H_{2\,(g)} + CO_{2\,(g)}$

Single Replacement

- Also referred to as single displacement
- One element replaces another
- Reactants must be an element and a compound.
- Products will be a different element and a different compound.
- A + BC → AC + B
- $2Na + SrCl_2 \rightarrow Sr + 2NaCl$
- $F_2 + LiCl \rightarrow LiF + Cl_2$

Single Replacement

- We can tell whether a reaction will happen
- Some are more active than other
- More active replaces less active

Double Replacement

- Two things replace each other.
- Reactants must be two ionic compounds or acids.
- Usually in aqueous solution

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

$$ZnS + 2HCl \rightarrow ZnCl + H_2S$$

$$AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$$

Combustion

- A reaction in which a compound (often carbon) reacts with oxygen
- $CH_4 + O_2 \rightarrow CO_2 + H_2O$
- $C_3H_8 + O_2 \rightarrow CO_2 + H_2O$
- $C_6H_{12}O_6 + O_2 \rightarrow CO_2 + H_2O$

Acid/Base Reaction

- An acid and a base react to form a salt and water.
- Always in aqueous solution
- **Acid (H^+) + Base (OH^-) → Salt + H_2O**

$$NaOH + HCl \rightarrow NaCl + H_2O$$

$$NH_4OH + H_2SO_4 \rightarrow (NH_4)_2SO_4 + H_2O$$

How to recognize which type

- Look at the reactants
  - Element(E), Compound(C)
- E + E
- C
- E + C
- C + C
- Acid + Base

Synthesis
Decomposition
Single replacement
Double replacement
Acid/Base reaction

- Look at the Products
- $CO_2 + H_2O$

Combustion

Examples

- $H_2 + O_2 \rightarrow$ Synthesis
- $H_2O \rightarrow$ Decomposition
- $AgNO_3 + NaCl \rightarrow$ Double replacement
- $Zn + H_2SO_4 \rightarrow$ Single replacement
- $HgO \rightarrow$ Decomposition
- $KBr + Cl_2 \rightarrow$ Single replacement
- $Mg(OH)_2 + H_2SO_3 \rightarrow$ Double replacement

Examples

- $HNO_3 + KOH \rightarrow$ Acid/Base
- $CaPO_4 \rightarrow$ Decomposition
- $AgBr + Cl_2 \rightarrow$ Single replacement
- $Zn + O_2 \rightarrow$ Synthesis
- $HgO + Pb \rightarrow$ Single replacement
- $HBr + NH_4OH \rightarrow$ Acid/Base
- $Cu(OH)_2 + KClO_3 \rightarrow$ Double replacement

Summary

An equation:

- Describes a reaction
- Must be balanced because to follow Law of Conservation of Energy
- Can only be balanced by changing the coefficients.
- Has special symbols to indicate state, and if catalyst or energy is required.
- Can describe 5 different types of reactions.