

Chemical Reactions

What is a Chemical Reaction?

Chemical Reaction – when substances go through a chemical change to form a new substances

Some Indicators of a Chemical Reaction

- 1) Heat and light have been released
- 2) A gas is produced (you see bubbles)
- 3) A precipitate is formed (a solid forms from two liquids)

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Reactions and Energy

Energy is needed to break chemical bonds but is released in forming new bonds.

Exothermic Reaction – More heat is released from a chemical reaction (gets hotter)

Endothermic Reaction – Heat is absorbed from surroundings of the chemical reaction (gets colder)

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Chemical Equations

Chemical Equation – identifies and relates the amounts of reactants and products in a chemical reaction

Characteristics of a Chemical Equation

- 1) Must represent reactants and products
- 2) Must have correct chemical formulas
- 3) Law of conservation must be satisfied

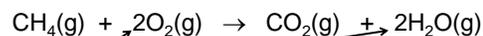
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Chemical Equations

Formula Equation – uses symbols used to describe a reaction

Significance of a Formula Equation

- 1) Coefficients show relative amounts of reactants and products
- 2) The reverse and forward reactions have same relative amounts



Coefficient – number indicating how many of something (just like math!)

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Balancing a Chemical Equation

- 1) Write word equation

methane + oxygen → carbon dioxide + water

- 2) Change names to formulas

$\text{CH}_4 + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{g})$ (Unbalanced)

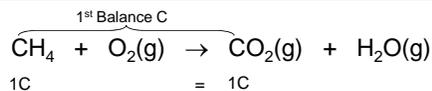
- 3) Balance using Law of Conservation (Trial and Error!!)

- a) Balance elements one at a time
- b) Balance combined elements appearing once on each side first
- c) Balance polyatomic ions on both sides as single units
- d) Balance H and O last

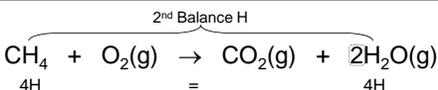
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Balancing a Chemical Equation

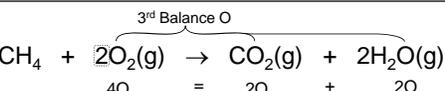
Step 1



Step 2



Step 3



Check



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Types of Chemical Reactions

Composition (or Synthesis) – two (or more) things combine

Decomposition – one thing breaks up

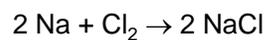
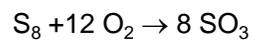
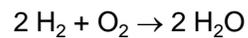
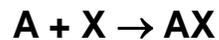
Single-Replacement (or Displacement) – one thing replaces another

Double-Replacement – two things swap parts in solution

Combustion (Burning) – something combines with oxygen
☺ FIRE!! ☺

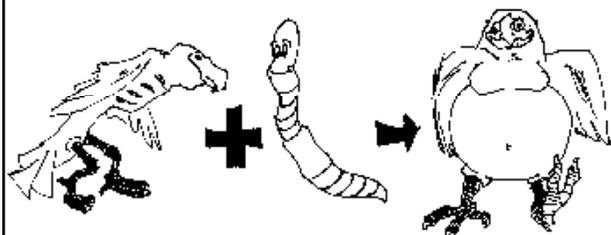
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Synthesis Reaction – two or more substances make a new compound. Also called **Composition**.



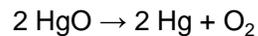
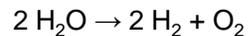
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Synthesis



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Decomposition Reaction – a substance breaks into two or more substances. These will often require heat or electricity to be added.



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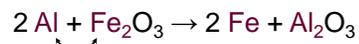
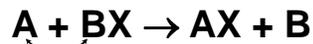
Decomposition



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Single-Replacement – one element replaces a similar element in a compound. Also called **Displacement**.

Metal Replacement



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Single Replacement

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Double-Replacement – ions in two compounds exchange in aqueous solution to form new compounds

$$AX + BY \rightarrow AY + BX$$

$$\text{CaCl}_2 + \text{Na}_2\text{CO}_3 \rightarrow \text{CaCO}_3 + 2 \text{NaCl}$$

$$\text{FeS} + 2 \text{HCl} \rightarrow \text{H}_2\text{S} + \text{FeCl}_2$$

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Double Replacement

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Combustion – a substance combines with oxygen releasing energy in the form of light and heat

Combustion is often described as “burning”. Combustion of hydrocarbons will form CO₂ and H₂O as products.

$$\text{C}_x\text{H}_y + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$$

$$\text{C}_3\text{H}_8 + 5 \text{O}_2 \rightarrow 3 \text{CO}_2 + 4 \text{H}_2\text{O}$$

Some combustion reactions are also synthesis reactions.

$$2 \text{H}_2 + \text{O}_2 \rightarrow 2 \text{H}_2\text{O}$$

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Combustion

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Describing Chemical Reactions

Aqueous – a substance that is dissolved in water

Precipitate – a solid that has separated from a solution by a chemical reaction

Supernate – liquid that remains above a solid produced by a chemical reaction

Aqueous substances dissolved in solution
Ex: Salt in water

Supernate
Precipitate

If you are not part of the solution... You are a part of the precipitate! ¹⁸

Symbols Used in Chemical Reactions

States of Reactants or Products

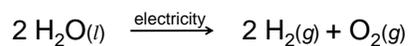
These are used to give information about specific compounds in a chemical reaction.

(s) - Substance is a solid

(l) - Substance is a liquid

(g) - Substance is a gas

(aq) aqueous – dissolved in water



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Changing Reaction Rate

Catalysts and inhibitors are used to control how fast a reaction will take place. A reaction shows if a catalyst is being used by placing it on type of the reaction arrow.



The above reaction uses manganese dioxide (MnO_2) as a catalyst to decompose hydrogen peroxide (H_2O_2) faster.

Catalyst – a substance that is used to speed up a reaction without being used up or changed

Inhibitor – a substance that is used to slow down a reaction without being used up or changed

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More Symbols in Chemical Equations

Special Conditions of a Reaction

$\xrightarrow{\text{MnO}_2}$ Catalyst or inhibitor is used to speed or slow the reaction

$\xrightarrow{\Delta}$ } Reactants are being heated
 $\xrightarrow{\text{Heat}}$ }

$\xrightarrow{0^\circ\text{C}}$ Reaction is at a specified temp

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Symbols Used in Chemical Equations

\longrightarrow
 Yields (reaction result)

\rightleftharpoons
 Reversible Reaction

State of Reactant or Product

(s) solid ↓ Precipitate

(l) liquid

(g) gas ↑ Gaseous product

(aq) aqueous – dissolved in water

Special Conditions of a Reaction

$\xrightarrow{\Delta}$ } Reactants heated
 $\xrightarrow{\text{Heat}}$ }

$\xrightarrow{2 \text{ atm}}$ At specified pressure
 $\xrightarrow{\text{pressure}}$ Under pressure

$\xrightarrow{0^\circ\text{C}}$ At specified temp

$\xrightarrow{\text{MnO}_2}$ Catalyst used to speed/slow reaction

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