Chapter 10 Lesson 1: Understanding Chemical Reactions

Vocabulary

-Chemical reaction	-reactant	-law of conservation of mass
-Chemical equation	-product	-coefficient

Changes in Matter

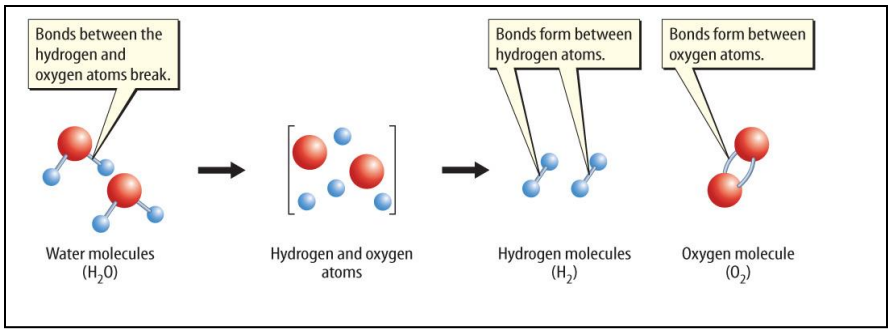
- A physical change does not produce new substances.
- For example, water molecules are always made up of two hydrogen atoms bonded to one oxygen atom regardless of whether they are solid, liquid, or gas.
- During a chemical change, one or more substances change into new substances.
- A **chemical reaction** is a process in which atoms of one or more substances rearrange to form one or more new substances.

Signs of a Chemical Reaction

- Changes in the physical properties of color, state of matter, and odor are all signs that a chemical reaction might have occurred.
- If substances get warmer or cooler or if they give off light or sound, it is likely that a chemical reaction has occurred.
- The only way to know if a chemical reaction has occurred is to study the chemical properties of the substances before and after the change.

What happens in a chemical reaction?

- In a chemical reaction, atoms of elements or compounds rearrange and form different elements or compounds.
- Atoms rearrange when chemical bonds between atoms break.
- Notice that no new atoms are created in a chemical reaction. The existing atoms rearrange and form new substances.



Chemical Equations

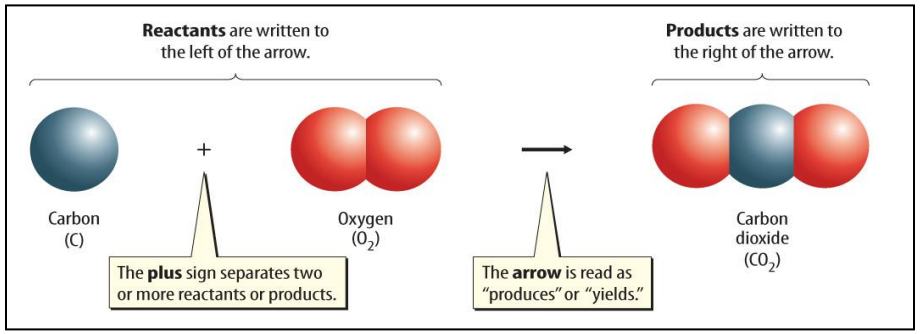
- A **chemical equation** is a description of a reaction using element symbols and chemical formulas.
- In chemical equations, element symbols represent elements and chemical formulas represent compounds.
- A subscript describes the number of atoms of an element in a compound.
- If an element's symbol does not have a subscript, the compound contains only one atom of that element.

Symbols and Formulas of Some Elements and Compounds

Substance	Formula	# of atoms
Carbon	C	C: 1
Copper	Cu	Cu: 1
Cobalt	Co	Co: 1
Oxygen	O_2	O: 2
Hydrogen	H_2	H: 2
Chlorine	Cl_2	Cl: 2
Carbon dioxide	CO_2	C: 1 O: 2
Carbon monoxide	CO	C: 1 O: 1
Water	H_2O	H: 2 O: 1
Hydrogen peroxide	H_2O_2	H: 2 O: 2
Glucose	$C_6H_{12}O_6$	C: 6 H: 12 O: 6
Sodium chloride	NaCl	Na: 1 Cl: 1
Magnesium hydroxide	$Mg(OH)_2$	Mg: 1 O: 2 H: 2

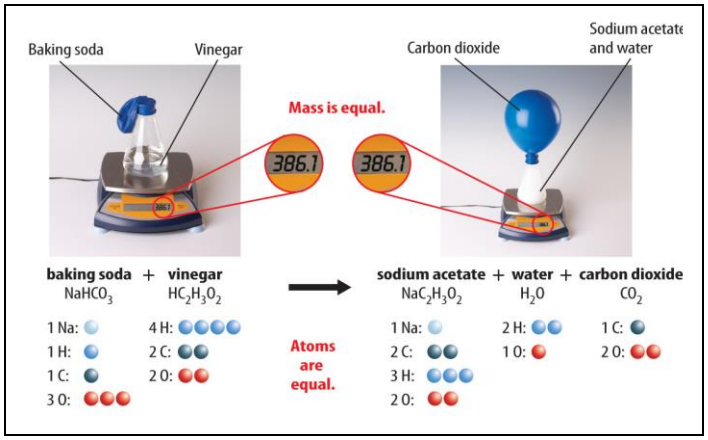
- A chemical equation includes both the substances that react and the substances that are formed in a chemical reaction.
- The starting substances in a chemical reaction are **reactants**.
- The substances produced by the chemical reaction are **products**.
- The reactants are written to the left of the arrow.
- The products are written to the right of the arrow.
- The general structure for a chemical equation is:

  reactant + reactant product + product
- An equation is read much like a sentence. This equation is read as "carbon plus oxygen produces carbon dioxide."

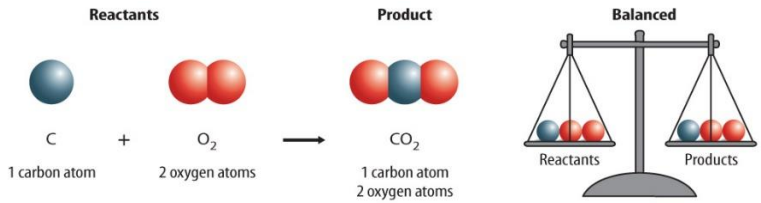


Conservation of Mass

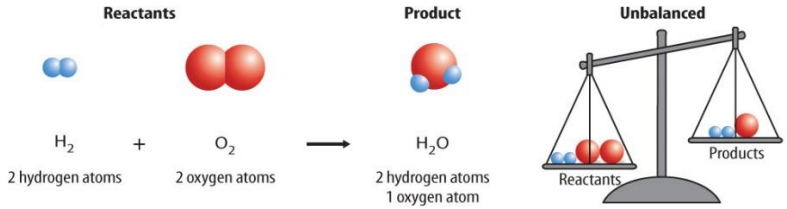
- The **law of conservation of mass** states that the total mass of the reactants before a chemical reaction is the same as the total mass of the products after the chemical reaction.
- Mass is conserved in a reaction because atoms are conserved.
- All atoms at the start of a chemical reaction are present at the end of the reaction.
- Mass is conserved in the reaction between baking soda and vinegar.



- A chemical equation is written so that the number of atoms of each element is the same, or balanced, on each side of the arrow.



- A balanced equation often does not happen automatically when the formulas for reactants and products are written.

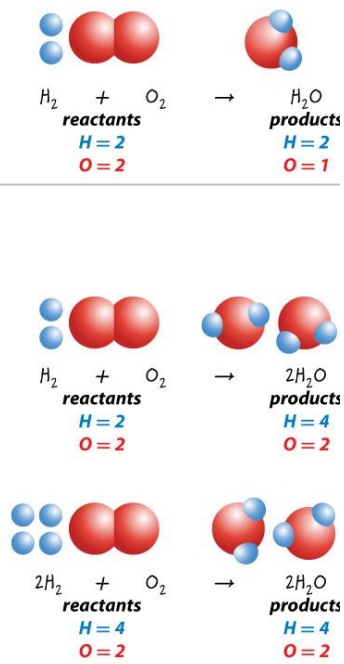


- A **coefficient** is a number placed in front of an element symbol or chemical formula in an equation.
- Only coefficients can be changed when balancing an equation.
- Changing subscripts changes the identities of the substances that are in the reaction.

- When no coefficient is present, only one unit of the substance takes part in the reaction.

- **Balancing a Chemical Equation**

1 Write the unbalanced equation. Make sure that all chemical formulas are correct.	$H_2 + O_2 \rightarrow H_2O$ (reactants → products)
2 Count atoms of each element in the reactants and in the products. **a.** Note which, if any, elements have a balanced number of atoms on each side of the equation. Which atoms are not balanced? **b.** If all of the atoms are balanced, the equation is balanced.	$H_2 + O_2 \rightarrow H_2O$ reactants: H = 2, O = 2; products: H = 2, O = 1
3 Add coefficients to balance the atoms. **a.** Pick an element in the equation that is not balanced, such as oxygen. Write a coefficient in front of a reactant or a product that will balance the atoms of that element. **b.** Recount the atoms of each element in the reactants and the products. Note which atoms are not balanced. Some atoms that were balanced before might no longer be balanced. **c.** Repeat step 3 until the atoms of each element are balanced.	$H_2 + O_2 \rightarrow 2H_2O$ reactants: H = 2, O = 2; products: H = 4, O = 2 $2H_2 + O_2 \rightarrow 2H_2O$ reactants: H = 4, O = 2; products: H = 4, O = 2
4 Write the balanced chemical equation including the coefficients.	$2H_2 + O_2 \rightarrow 2H_2O$



Chapter 10 Lesson 2: Types of Chemical Reactions

Vocabulary

-synthesis	-single replacement	-combustion
-decomposition	-double replacement	

Patterns in Reactions

- The breakdown of one reactant into two or more products is one of four major types of chemical reactions.
- Each type of chemical reaction follows a unique pattern in the way atoms in reactants rearrange to form products.

Types of Chemical Reactions

- A **synthesis** is a type of chemical reaction in which two or more substances combine and form one compound.

Synthesis Reactions

Examples:
$2Na + Cl_2 \rightarrow 2NaCl$
$2H_2 + O_2 \rightarrow 2H_2O$
$H_2O + SO_3 \rightarrow H_2SO_4$

$2Mg + O_2 \rightarrow 2MgO$
magnesium, oxygen, magnesium oxide

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- In a **decomposition** reaction, one compound breaks down and forms two or more substances.

Decomposition Reactions

Examples:
$CaCO_3 \rightarrow CaO + CO_2$
$2H_2O \rightarrow 2H_2 + O_2$
$2KClO_3 \rightarrow 2KCl + 3O_2$

$2H_2O_2 \rightarrow 2H_2O + O_2$
hydrogen peroxide, water, oxygen

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- In a **single-replacement** reaction, one element replaces another element in a compound.

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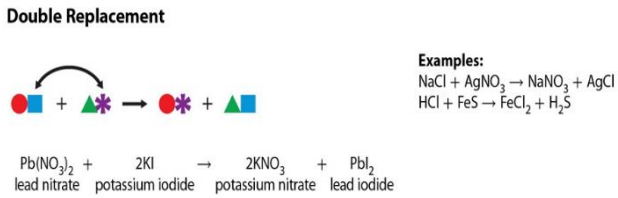
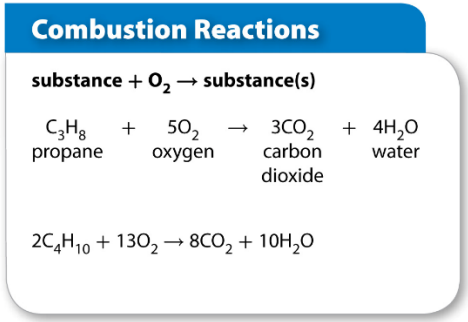
- In a **double-replacement** reaction, the negative ions in two compounds switch places, forming two new compounds.



- **Combustion** is a chemical reaction in which a substance combines with oxygen and releases energy.



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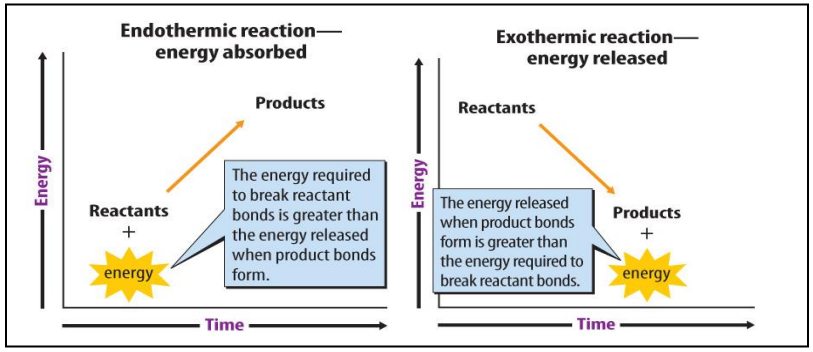
Chapter 10 Lesson 3: Energy Changes and Chemical Reactions

Vocabulary

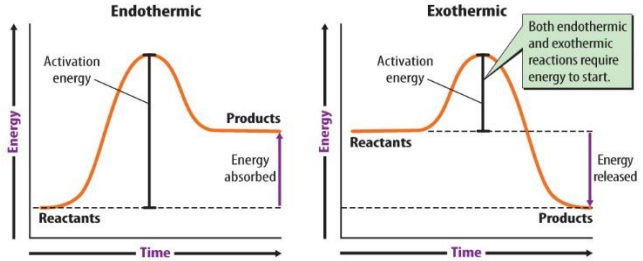
-endothermic	-activation energy	-enzyme
-exothermic	-catalyst	-inhibitor

Energy Changes

- Chemical bonds contain a form of energy called chemical energy.
- Breaking a bond absorbs energy from the surroundings.
- The formation of a chemical bond releases energy to the surroundings.
- Some chemical reactions release more energy than they absorb.
- Some chemical reactions absorb more energy than they release.
- Energy is conserved in all chemical reactions.
- Chemical reactions that absorb thermal energy are **endothermic reactions.**
- In an endothermic reaction, more energy is required to break the bonds of the reactants than is released when the products form.
- An **exothermic reaction** is a chemical reaction that releases thermal energy.
- In an exothermic reaction, more energy is released when the products form than is required to break the bonds in the reactants.



- **Activation energy** is the minimum amount of energy needed to start a chemical reaction.



Reaction Rates

- The rate of a reaction is the speed at which it occurs.
- Chemical reactions occur faster if particles collide more often or move faster when they collide.
- Increased surface area increases reaction rate because more particles on the surface of a solid come into contact with the particles of another substance.
- At higher temperatures, the average speed of particles is greater, particles collide more often, and collisions with more energy are more likely to break chemical bonds.
- Increasing the concentration of one or more reactants increases collisions between particles, resulting in a fast reaction rate.
- In gases, an increase in pressure pushes gas particles closer together, resulting in more collisions.
- A **catalyst** is a substance that increases reaction rate by lowering the activation energy of a reaction.
- An **enzyme** is a catalyst that speeds up chemical reactions in living cells.
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- An **inhibitor** is a substance that slows, or even stops, a chemical reaction.