6th Grade
Introduction to Chemistry

Chapter 5: Chemical Reactions

Lesson 1 (Observing Chemical Change)

Atom – the basic particle from which all elements are made

Parts of an Atom:

proton (p^+) – small **positively** charged particles that are found **in the nucleus** of an atom.

neutron (n) – a small particle **in the nucleus** of an atom with **no** electrical charge. (It is **neutral**.)

electron (e^-) – a tiny **negatively** charged particle that moves around the **outside of the nucleus** of an atom.

– This is the only part of an atom that can leave the atom.

Nucleus – the dense central core of an atom that contains **protons** and **neutrons**.

Neutral – having no electrical charge

– An atom with equal numbers of protons (positive charge) and electrons (negative charge) is neutral.

– The positive charges from the protons cancel out the negative charges from the electrons.

– Atoms tend to have a neutral charge unless something has happened to them.

Ion – an atom that has become electrically charged.

– If an atom gains electrons, it becomes negatively charged. (It now has more negative charges than positive charges.)

– If an atom loses electrons, it becomes positively charged. (It now has more positive charges than negative charges.)

Examples of ion symbols:

Na^+ (lost 1 electron)

Mg^{2+} (lost 2 electrons)

S^{2-} (gained 2 electrons)

Al^{3+} (lost 3 electrons)

Atoms and Bonding:

1. Atoms bond with other atoms to form molecules by gaining, losing, or sharing electrons with other atoms.
2. This creates atoms of opposite charges (+ and –) that are held together by a force of attraction (a chemical bond).

Physical property – a characteristic of a substance that can be observed or measured without changing it into another substance.

Examples:

State of matter (solid, liquid, or gas)	freezing point	melting point
boiling point	density	color
size	shape	weight
mass	hardness	flexibility
ability to conduct heat or electricity	temperature	texture

Chemical property – a characteristic of a substance that describes its ability to change into different substances

– To observe the chemical properties of a substance, you must try to change it into another substance.

Examples: rusting
tarnishing
flammability
light sensitivity

Physical change – alters the form or appearance of matter, but does not turn any substance in the matter into a new substance
– A substance that undergoes a physical change is still the same substance after the change.

Examples: melting freezing evaporating
breaking bending dissolving

Chemical change – a change in matter that produces one or more new substances
– also called a chemical reaction
– The new substances have new and different properties.

Examples: combustion
electrolysis
oxidation
tarnishing

Bonding and Chemical Change:

1. During chemical reactions, existing bonds break and new bonds form.
2. This breaks down existing molecules and forms new substances.

Reactants – substances that undergo chemical changes

Products – the new substances formed from a chemical change (chemical reaction)

How do you decide a chemical reaction has occurred?

1. A precipitate may have formed.
   precipitate – a solid that sometimes forms when liquids are mixed
2. A gas may be produced. (bubbles form)
3. A sound may be produced. (fizzing, crackling, or a loud boom)
4. The color may change. (Newspapers turn yellow over time.)
5. The odor may change. (Toast smells different than bread.)
6. Smoke may be produced.
7. Light may be given off. (Sparks or flames arise.)
8. The temperature may change. (warmer or colder)
9. A new substance has been produced.

Exothermic reaction – a reaction that releases (produces, or gives off) energy
– usually in the form of heat
– This would feel warm to the touch.

Endothermic reaction – a reaction that absorbs (takes in) energy, usually in the form of heat
– This would feel cold to the touch as it takes in heat from your hand.

Lesson 2 (Describing Chemical Reactions)

Chemical symbol – a one or two letter representation of an element
– The first letter is always capitalized.

Examples: K Na Cl Xe N

Chemical formula – symbols that show the elements in a compound and the ratio of atoms

Examples: H_2O CO_2 H_2SO_4
O_2 $C_{12}H_{22}O_{11}$

Subscript – a number in a chemical formula that tells the number of each atom in a molecule

– Subscripts tell the ratio of elements in a compound.

H_2O

subscript

Coefficient – a number placed in front of a chemical formula

– tells the number of molecules present

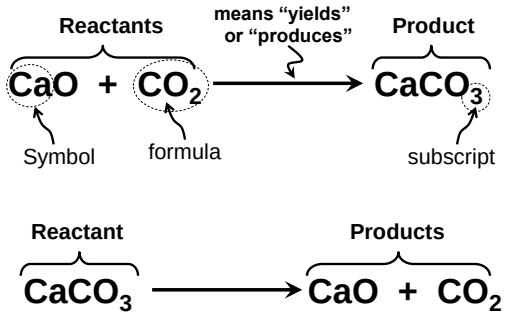
$2H_2O$

coefficient

Chemical equation – a way to show a chemical reaction using formulas and other symbols instead of words

– tells you the **reactants** (what you start with) and **products** (what is formed)

– All of the atoms at the start of the reaction are present at the end of the reaction.



Balancing equations:

(not balanced)

$H_2 + O_2 \longrightarrow H_2O$

2 hydrogen atoms, 2 oxygen atoms | 2 hydrogen atoms, 1 oxygen atom

(balanced)

$2\,H_2 + O_2 \longrightarrow 2\,H_2O$

4 hydrogen atoms, 2 oxygen atoms | 4 hydrogen atoms, 2 oxygen atoms

Types of Chemical Reactions:

1. **Synthesis reaction** – two or more simple substances combine to form a new, more complex substance.

Examples:

$H_2 + O_2 \longrightarrow H_2O$

$Ca + O_2 \longrightarrow CaO$

$Mg + P_4 \longrightarrow Mg_3P_2$

} Not balanced equations

2. **Decomposition reaction** – breaks down compounds into simpler products

Examples:

$2H_2O_2 \longrightarrow 2H_2O + O_2$

$2Mg_3P_2 \longrightarrow 6Mg + P_4$

$2CaO \longrightarrow 2Ca + O_2$

} balanced equations

3. **Single Replacement reaction** – when one element replaces another in a compound

Examples:

$2Cu_2O + C \longrightarrow 4Cu + CO_2$

$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$

} Elements trading places.

4. **Double replacement reaction** – when two elements in different compounds trade places.

Example: $FeS + 2HCl \longrightarrow FeCl_2 + H_2S$

Lesson 3 (Controlling Chemical Reactions)

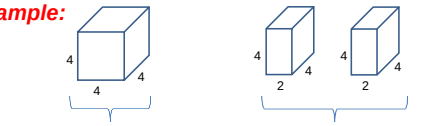
Activation energy – the minimum amount of energy needed to start a chemical reaction

– All chemical reactions need a certain amount of energy to break the bonds of the reactants so the atoms can be rearranged into the products.

Factors that Affect the Rate of a Chemical Reaction:

1. The **surface area** of the reactants
   – If the reactants are broken into smaller pieces, more of each reactant is available to react.

Example:



Surface area = 4 x 4 x 6 sides = 96

area = 4 x 2 x 8 sides = 64
4 x 4 x 4 sides = 64
total area = **128**

We now have more area for reactants to come in contact with each other. (This makes the reaction go faster.)

2. The **temperature** of the reactants
   – Increasing the temperature speeds up reactions.
   – Decreasing the temperature slows down reactions.
3. The **concentration** of the reactants
   – Increasing the concentration speeds up reactions by supplying more particles to react.

concentration – the amount of substance in a certain volume

example: A gallon of water with 2 cups of sugar added has a higher concentration (is more concentrated) than a gallon of water with 1 cup of sugar added.

4. The addition of **catalysts** or **inhibitors**.

Catalyst – a material that increases the reaction rate (speeds up chemical reactions)

Example: **Enzymes** – proteins made by the body that speed up chemical reactions in living things

Inhibitor – a material that decreases the reaction rate (slows down reactions)