

Chapter 8 notes

Earth Chemistry

8.1 Matter

8.1 objectives

- **Compare** chemical properties and physical properties of matter.
- **Describe** the basic structure of an atom.
- **Compare** atomic number, mass number, and atomic mass.
- **Define** *isotope*.
- **Describe** the arrangement of elements in the periodic table.





Properties of Matter

- **matter** anything that has mass and takes up space
- Every object in the universe is made up of particles of matter. The amount of matter in any object is the **mass** of that object.
- All matter has two types of distinguishing properties—physical properties and chemical properties.

Physical & Chemical Properties

- **Physical properties** are characteristics that can be observed without changing the composition of the substance.
- Physical properties include density, color, hardness, freezing point, boiling point, and the ability to conduct an electric current.
- **Chemical properties** are characteristics that describe how a substance reacts with other substance to produce different substances.

Comparing Physical & Chemical Properties

	Iron	Red food color
Physical property	Malleability 	Red color 
Chemical property	Reactivity with oxygen 	Reactivity with bleach 

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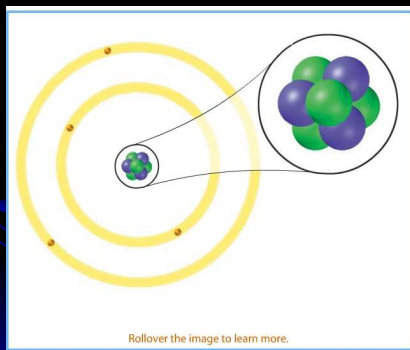
Elements

- **Element:** a substance that cannot be separated or broken down into simpler substances by chemical means.
- Each element has a set of physical and chemical properties that identify it.
- Every known element is represented by a symbol of one or two letters.

Atoms

- Elements are made of atoms.
- **atom** the smallest unit of an element that maintains the chemical properties of that element
- A single atom is so small that its size is difficult to imagine.

Parts of the Atom



Atomic Structure

- Atoms are made up of smaller parts called subatomic particles.
- 3 types of subatomic particles—protons, electrons, and neutrons.
- **proton**: has a positive charge; located in the nucleus of an atom; the number of protons of the nucleus is the atomic number, which determines the identity of an element
- **electron**: has a negative charge; not in the nucleus
- **neutron**: has no charge; located in the nucleus

Nucleus & Electron Cloud

- The protons + neutrons = **nucleus**.
- The positively charged nucleus makes up most of an atom's mass but very little of its volume. The volume of an atom is mostly empty space.
- The electrons of an atom move in a certain region of space called an **electron cloud** that surrounds the nucleus.
- The negatively charged electrons are attracted to the positively charged nucleus. This attraction holds electrons in the atom.

Atomic Number

- The **number of protons** = **atomic number**.
- All atoms of any given element have the same atomic number. An element's atomic number is unique for each element.
- Elements on the **periodic table** are ordered according to their atomic numbers.
- Elements in the same column on the periodic table have similar arrangements of electrons in their atoms, and therefore have similar chemical properties.

Isotopes

- **isotope:** an atom that has the same number of protons but has a different number of neutrons (and thus a different atomic mass)
- Because of their different number of neutrons and their different masses, different isotopes of the same element have slightly different properties.

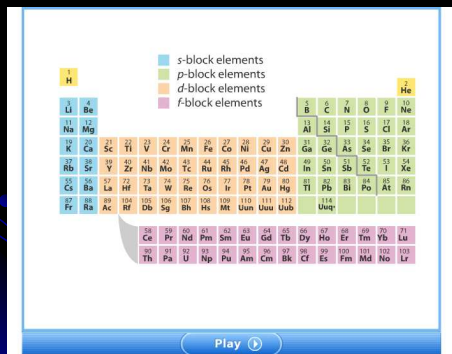
Isotope examples

Hydrogen-1, ${}^1_1\text{H}$
1 proton
1 electron
Atomic number 1
Mass number 1

Hydrogen-2, ${}^2_1\text{H}$
1 proton
1 neutron
1 electron
Atomic number 1
Mass number 2

Hydrogen-3, ${}^3_1\text{H}$
1 proton
2 neutrons
1 electron
Atomic number 1
Mass number 3

Periodic Table overview



Periodic Table – pages 142/143

Key:
 Atomic number
 Symbol
 Name
 Average atomic mass

Carbon Example:
 Atomic number: 6
 Symbol: C
 Name: Carbon
 Average atomic mass: 12.0107

Notes:
 Hydrogen
 Lanthanides
 Actinides
 Metals
 Alkali metals
 Alkaline earth metals
 Transition metals
 Other metals
 Nonmetals
 Halogens
 Noble gases
 Other nonmetals

Atomic Mass

- protons + neutrons = the **mass number**.
- The mass of a subatomic particle is too small to be expressed easily in grams, so a special unit called the **atomic mass unit** (amu) is used.
- Protons and neutrons each have an atomic mass close to 1 amu.
- Electrons have much less mass than protons or neutrons do. The mass of 1 proton is equal to the combined mass of about 1,840 electrons.
- Because electrons add little to an atom's total mass, their mass can be ignored when calculating an atom's approximate mass.

Summary of Atomic terms

- Atomic number = # of protons
- Mass number = protons + neutrons
- Atomic mass = protons + neutrons + electrons

Solids, Liquids, and Gases

- **solid**: definite shape & volume
- **liquid**: definite volume, no definite shape
- **gas**: no definite shape, no definite volume
- Particles are closest together in solids; farthest apart in gases.

8.2 Combinations of Atoms

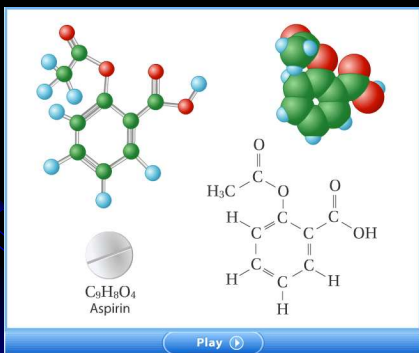
8.2 objectives

- **Define** *compound* and *molecule*.
- **Interpret** chemical formulas.
- **Describe** two ways that electrons form chemical bonds between atoms.
- **Explain** the differences between compounds and mixtures.

Compounds

- Elements rarely occur in pure form in Earth's crust. They generally occur in combination with other elements.
- **compound** a substance made up of atoms of two or more different elements joined by chemical bonds
- Examples: salt, water, rust, sugar

Compounds



Molecules

- **molecule** a group of atoms that are held together by chemical forces; a molecule is the smallest unit of matter that can exist by itself and retain all of a substance's chemical properties
- **diatomic molecules** are naturally occurring elements made up of two atoms.
- Examples: atmospheric oxygen = O_2 , atmospheric nitrogen = N_2

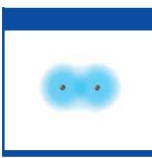

Electron Energy Levels

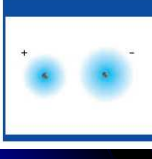
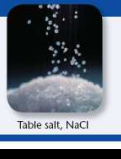
- Atoms bond based on the number of electrons in their outer shell.
- 1st energy level: 2 electrons max.
- 2nd + energy levels: 8 electrons max.
- If less than 4 electrons, atoms will donate electrons to make bonds.
- If 4 or more electrons in outer shell, atoms will gain electrons to make bonds.
- 8 electrons = full shell = stable compound

Chemical Bonds

- The forces that hold together the atoms in molecules are called **chemical bonds**.
- Chemical bonds form because of the attraction between positive and negative charges.
- Atoms form chemical bonds by: sharing electrons (**covalent bonds**) or transferring electrons (**ionic bonds**) from one atom to another.

Chemical Bonds

Covalent Bonds	
	Covalent bonds form when atoms share one or more pairs of electrons. In a covalent compound, pairs of electrons are shared between most of the atoms that make up the compound. Chlorine gas is an example of a covalent compound in which pairs of chlorine atoms are bonded together by sharing electrons.
	Chlorine gas, Cl ₂

Ionic Bonds	
	Ionic bonds form between ions that have opposite charges. To form an ionic compound, electrons are transferred from positively charged ions to negatively charged ions. Table salt is an ionic compound that results when electrons are transferred from positively charged sodium ions, Na ⁺ , to negatively charged chlorine ions, Cl ⁻ .
	Table salt, NaCl

Ionic Bonds

- When an electron is transferred from one atom to another, both atoms become charged.
- **ion** an atom or molecule that has gained or lost one or more electrons and has a negative or positive charge
- **ionic bond** the attractive force between oppositely charged ions, which form when electrons are transferred from one atom or molecule to another
- A compound that forms through the transfer of electrons is called an **ionic compound**. (like salt)

Covalent Bonds

- **covalent bond** a bond formed when atoms share one or more pairs of electrons
- A compound that forms through the sharing of electrons is called a **covalent compound**
- **Examples:** nitrogen gas, oxygen, water

Chemical Formulas

- A **chemical formula** is a combination of letters and numbers that shows which elements make up a compound and the number of atoms of each element that are required to make a molecule of a compound.
- In a chemical formula, the subscript that appears after the symbol for an element shows the number of atoms of that element that are in a molecule. **For example:**



Mixtures

- **mixture** a combination of two or more substances that are not chemically combined
- Because the substances that make up a mixture keep their individual properties, a mixture can be separated into its parts by physical means.
- **solution** a homogeneous mixture of two or more substances that are uniformly dispersed throughout the mixture
- Liquids, gases, and solids can all be solutions.
- An **alloy** is a solution composed of two or more metals, such as steel, brass, and bronze.
