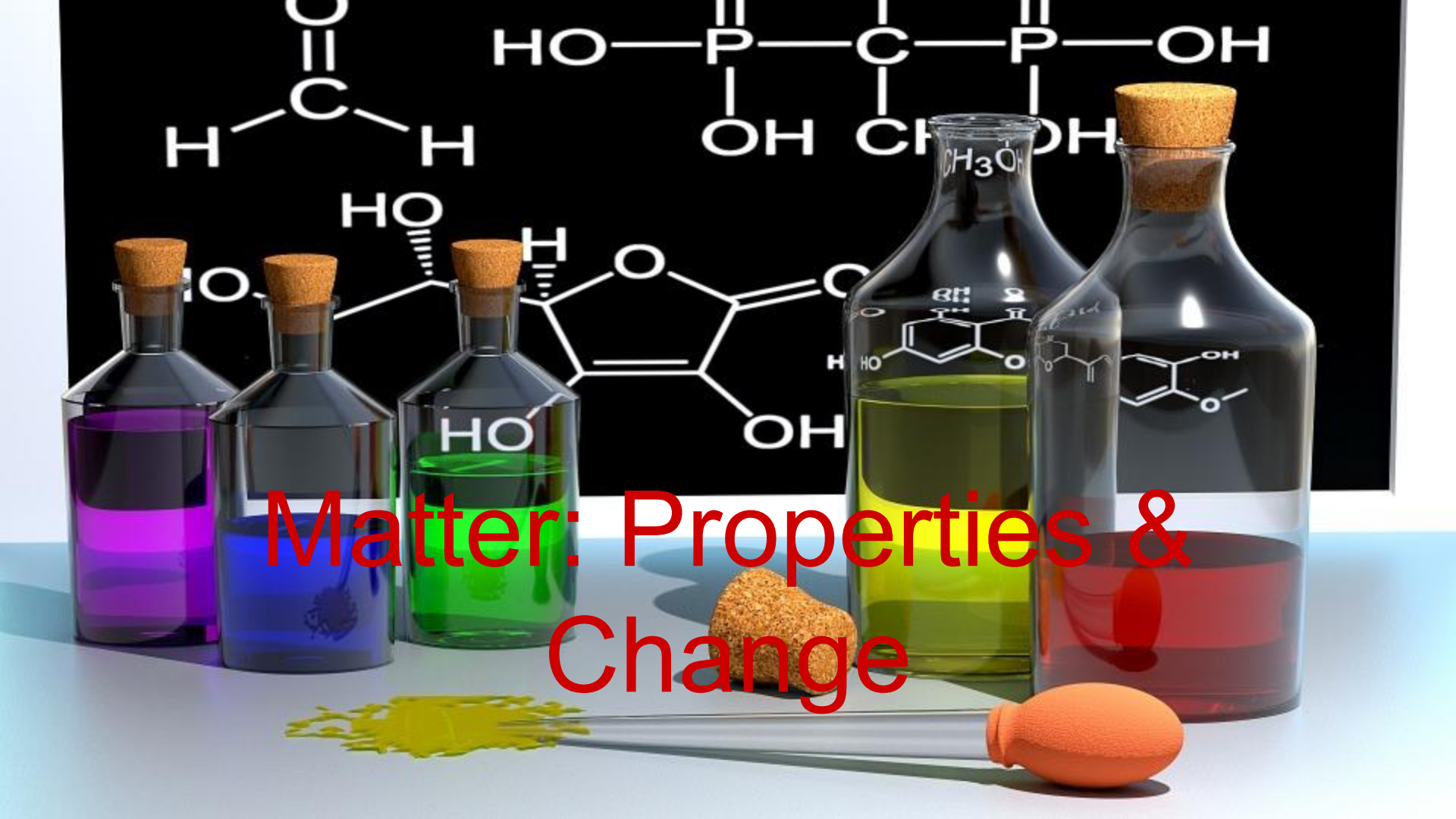

Matter: Properties & Change

Matter: Properties and Change

8.P.1 Understand the properties of matter and changes that occur when matter interacts in an open and closed container.

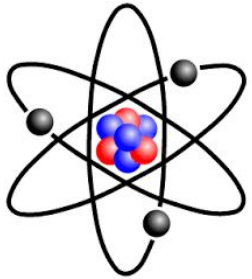
8.P.1.1 Classify matter as elements, compounds, or mixtures based on how the atoms are packed together in arrangements.

8.P.1.2 Explain how the physical properties of elements and their reactivity have been used to produce the current model of the Periodic Table of elements.

8.P.1.3 Compare physical changes such as size, shape and state to chemical changes that are the result of a chemical reaction to include changes in temperature, color, formation of a gas or precipitate.

8.P.1.4 Explain how the idea of atoms and a balanced chemical equation support the law of conservation of mass.

A Great Combination



How can matter be classified?

- Matter is made up of basic “ingredients” known as atoms.

- An **atom** is the smallest unit of an element that maintains the properties of that element.

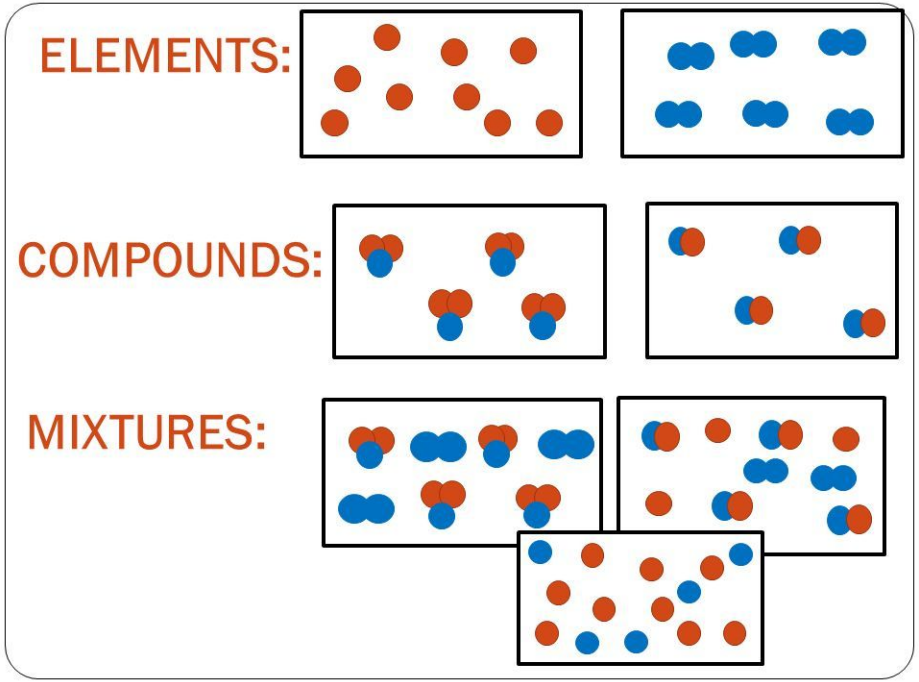
- Substances are classified as *elements, compounds*, and *mixtures*.

How can matter be classified?

- An **element** is made of only one kind of atom.

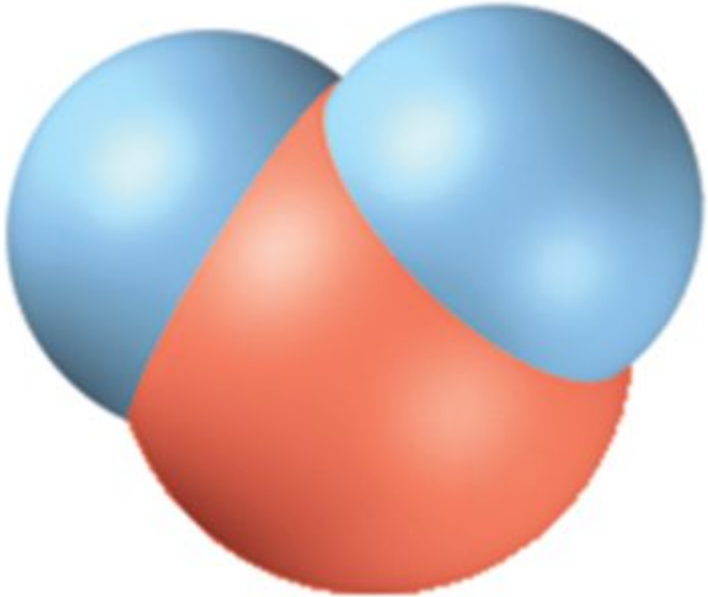
- A **compound** is made up of different kinds of atoms that are chemically combined.

- A **mixture** contains a variety of elements and compounds that are not chemically combined.

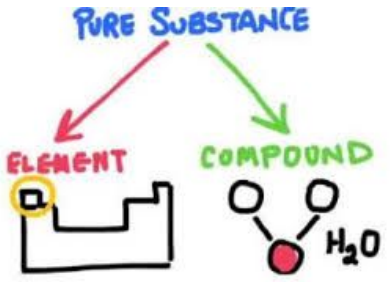


How can matter be classified?

- Is water an element, a compound, or a mixture?



Pure Genius



What are pure substances?

- A **pure substance** is a substance with definite physical and chemical properties.

- Pure substances are made up of just one type of particle.

- Elements and compounds are pure substances.

What are pure substances?

- Physical changes such as melting, freezing, cutting, or smashing do not change the identity of pure substances.

- When a pure substance undergoes a chemical change, it is no longer that same substance.

Physical Changes

Crushing a can

Melting an ice cube

Boiling water

Mixing sand with water

Breaking glass

Dissolving sugar in water

Shredding paper

Chopping wood

Mixing green and red marbles

Sublimation of dry ice

ThoughtCo.

Classified Information

How can elements be classified?

- Elements are classified as metals, nonmetals, or metalloids.

- Classifying elements helps scientists predict the properties of elements.

- The periodic table is a tool used to classify and identify elements that have similar properties.

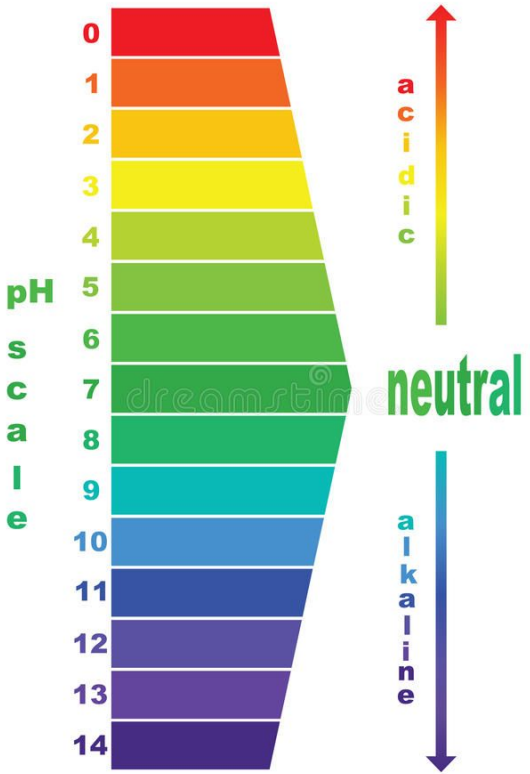
How can compounds be classified?

- Compounds can be classified as acidic, basic, or neutral by measuring *pH*.

- Pure water has a pH of 7. Acids have a pH below 7. Bases have a pH above 7.

- Blue litmus paper turns red in the presence of an acid.

- Red litmus paper turns blue in the presence of a base.



How can compounds be classified?

- Compounds can be organic or inorganic.
- *Organic* compounds are those that contain carbon and hydrogen.
- Organic compounds made by living things are called biochemicals.
- *Carbohydrates, lipids, proteins,* and *nucleic acids* are biochemical compounds.

Organic vs. Inorganic

Organic

- **Have C & H together**
- **Made by living things**

Inorganic

- **Have C or H or neither, but never both at the same time.**
- **Can be found in living things**

Mix and Match

What are mixtures?

- A mixture is a combination of two or more substances that are combined physically but not chemically.

- Mixtures are not pure substances and do not have definite properties.

What are mixtures?

- Substances within a mixture keep their identities and individual properties.

- Mixtures can be separated by physical changes, although some mixtures are difficult to separate.

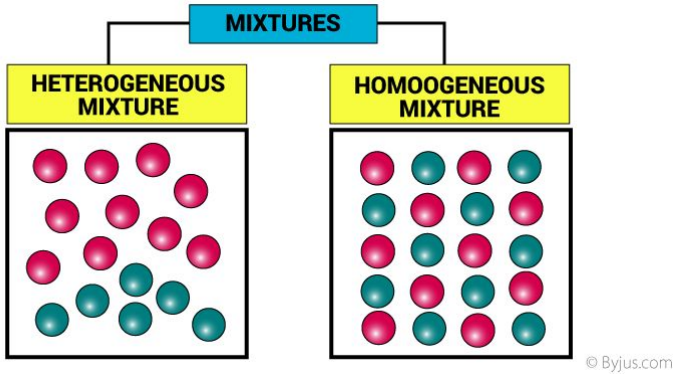
- Magnets, centrifuges, filters, and other materials can be used to separate mixtures.

Simple Solution

How can mixtures be classified?

- A **heterogeneous** mixture is one that does not have a uniform composition.

- A **homogeneous** mixture has the same composition throughout.



How can mixtures be classified?

- A *suspension* is a heterogeneous mixture.

- Particles in a suspension are spread throughout a liquid or gas, but are too large to stay mixed unless shaken or stirred.

- Particles settle in suspensions.

How can mixtures be classified?

- A *solution* is a homogeneous mixture in which one substance is dissolved in another substance.

- *Colloids* have particles that are unevenly spread throughout the mixture.

- Unlike a suspension, particles in colloids are too small to settle out of the mixture.

Solution

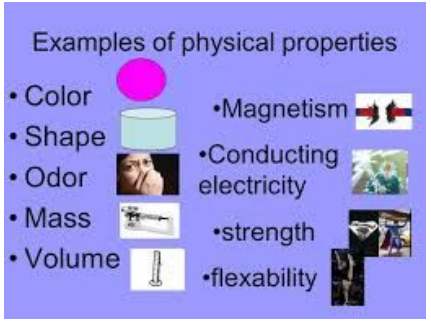
Colloid

Physical Education

What are physical properties of matter?

•A characteristic of a substance that can be observed without changing the identity of the substance is called a **physical property**.

•All of the senses can be used to observe physical properties.



What are physical properties of matter?

- Mass and volume are physical properties.

- Changing the mass or volume of a substance does not change the substance’s identity.

- The state of matter is a physical property. The state of matter is the physical form of the matter.

- Most matter exists as a solid, liquid, or gas.

What are physical properties of matter?

- Electrical conductivity is a measure of how well electric currents move through a substance.

- Density is the measure of the amount of matter in a given volume.

- Thermal conductivity is the rate at which a substance transfers heat.

What are physical properties of matter?

- Solubility is the ability of a substance to dissolve in another substance.

- Malleability is the ability of a substance to be rolled or pounded into various shapes.

- Magnetic attraction is also a physical property that can be observed.

What are physical properties of matter?

- The shine, or luster, of a metal can be easily observed.

- The melting point of a substance is the temperature at which it changes from a solid to a liquid.

- The boiling point of a substance is the point at which the substance boils.

Identity Theft

What are chemical properties of matter?

•A **chemical property** describes the ability of a substance to change into a new substance with different properties.

•The ability to rust or tarnish is a chemical property. When a metal rusts or tarnishes, it changes to a different substance.

What are chemical properties of matter?

- Chemical properties can be identified by the changes they produce.

- Flammability is the ability of a substance to burn.

- Reactivity is the ability of a substance to interact with another substance and form one or more new substances.

Property Boundaries

What is the difference between physical and chemical properties?

- Physical properties can be observed without changing the identity of a substance.

- Chemical properties can be observed only by changing the identity of a substance.

Physical vs. Chemical Properties

- Physical Properties
  - Color
  - Shape
  - Size
  - Density
  - Amount
  - Volume
- Chemical Properties
  - Flammability
  - Rusting
  - Burning
  - Corrosion
  - Reactivity

At the Scene

- The collection and study of physical evidence in a criminal investigation is known as *forensic science.*

- Ashes from an arson scene can be heated to determine chemicals used to start a fire.

- Flecks of paint and the analysis of fibers can provide clues to criminal cases.

Identify Yourself

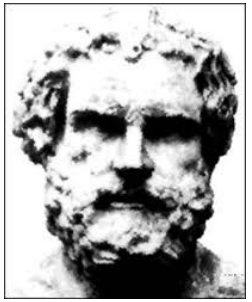
How can physical and chemical properties identify a substance?

- Properties unique to a substance are its *characteristic properties.*

- Characteristic properties stay the same regardless of the amount of the sample.

- Characteristic properties can be physical properties or chemical properties.

As a Matter of Fact



What makes up matter?

- The Greek philosopher Democritus thought matter could be divided into smaller units until you obtained a particle that could not be cut.

- He called this particle *atomos*, meaning "not able to be divided."

- Scientists have come to agree that matter is made up of small particles, and they use the term *atom* to describe them.

What makes up matter?

- An **atom** is the smallest particle into which an element can be divided and still be the same element.

- Scientists now know that atoms are made of even smaller particles, but the atom is the smallest unit that has the chemical properties of an element.

- There are many types of atoms that combine in different ways to make all substances.

Something Old, Something New

Who developed the atomic theory?

- In 1808, John Dalton published an atomic theory, stating that all matter is made up of atoms that cannot be created, divided, or destroyed.

- This theory also stated that all atoms of a certain element are identical, but they differ from atoms of all other elements.
- Every substance is made up of atoms combined in certain ways.

Who developed the atomic theory?

- In 1897, J. J. Thomson's experiments provided evidence that atoms contain negatively charged particles, which were later called **electrons**.

- Thomson thought that an atom was a positive sphere with the electrons mixed through it.

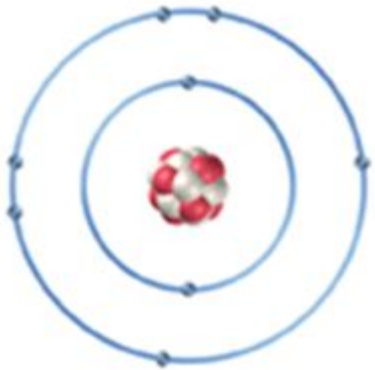
Who developed the atomic theory?

- In 1909, Ernest Rutherford's experiment suggested that atoms have a **nucleus**—a small, dense center that has a positive charge.

- Rutherford later found that the nucleus is made up of smaller, positively charged particles that he called **protons**.

Who developed the atomic theory?

- Niels Bohr suggested a model in which electrons move around the nucleus in circular paths, with each path at a certain distance from the nucleus.



What is the current atomic theory?

- In 1932, James Chadwick discovered that the nucleus contains uncharged particles called **neutrons**.

- In the current atomic theory, electrons do not move in circular paths around the nucleus as Bohr thought.

- Instead, the current theory suggests that electrons move within an area around the nucleus called the **electron cloud**.

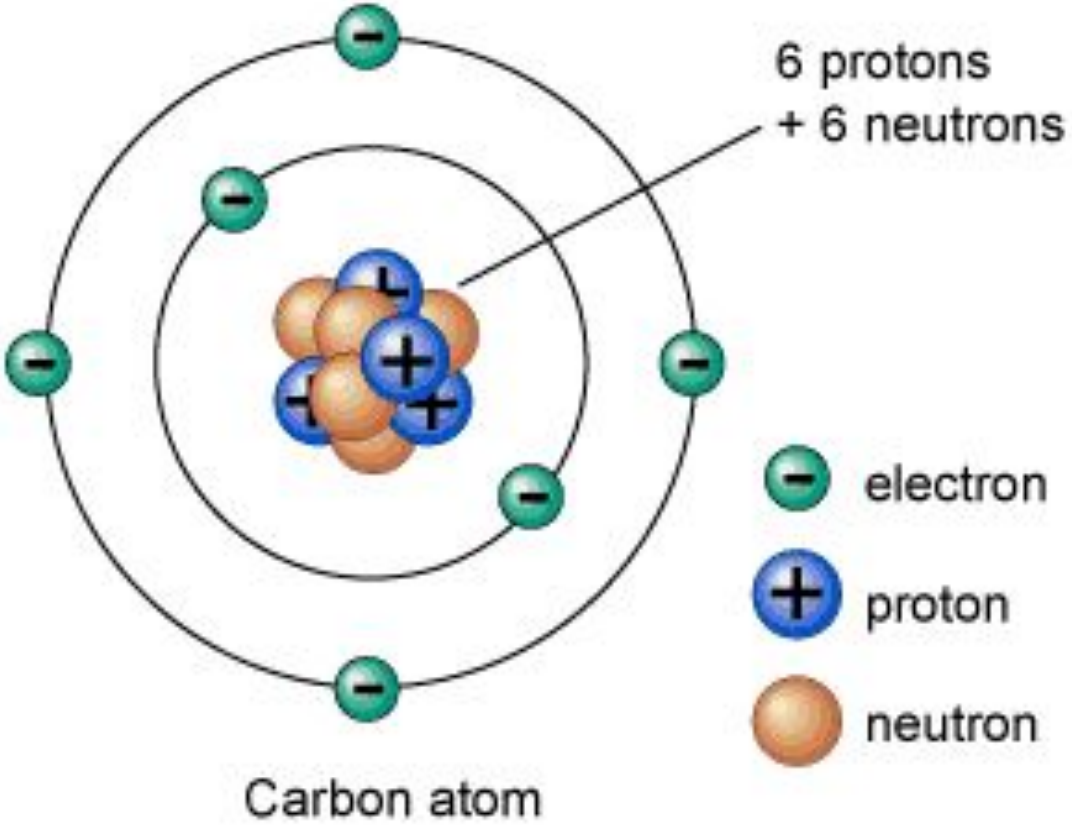
Up and Atom!

What are the parts of an atom?

- Atoms are made up of protons, neutrons, and electrons.

- Protons are the positively charged particles of atoms. The relative charge of a single proton is written as 1+.

- In the unified atomic mass unit (u), the mass of a proton is about 1 u.


6 protons
+ 6 neutrons
electron
proton
neutron
Carbon atom

What are the parts of an atom?

- Neutrons are particles that have no electrical charge.

- The mass of a neutron is slightly more than that of a proton, but it is still close to 1 u.

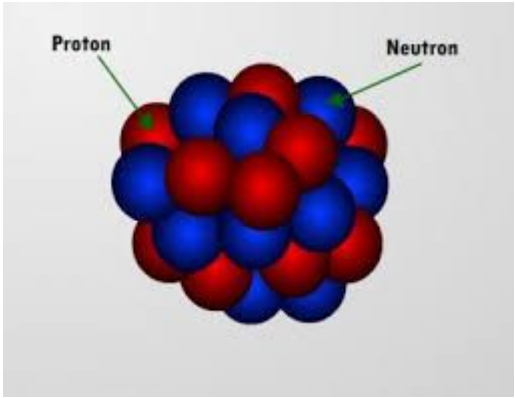
- Most atoms contain at least as many neutrons as protons.

What are the parts of an atom?

- Together, protons and neutrons form the nucleus of the atom.

- The overall charge of the nucleus is equal to the charge on the total number of protons in the nucleus.

- The nucleus is small but very dense.



What are the parts of an atom?

- The negatively charged particles of an atom are called electrons. The charge of a single electron is represented as 1-.

- It is not possible to determine the exact position and speed of an electron at the same time.

- So we picture the electrons as being in an electron cloud around the nucleus.

What are the parts of an atom?

- Compared with protons and neutrons, electrons have very little mass.

- The number of protons and electrons in an atom are the same, so their charges are balanced and the atom has an overall charge of 0.

- An atom can gain or lose electrons to become an *ion,* which has a net positive or negative charge.

Take a Number!

How can we describe atoms?

- Different combinations of protons, neutrons, and electrons produce atoms with different properties.

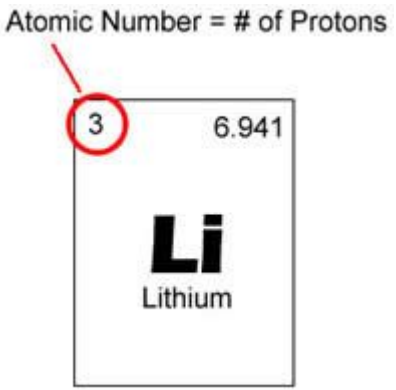
- The number of each kind of particle within an atom determines its unique properties.

- These different atoms combine to form the different substances all around us.

How can we describe atoms?

- The number of protons distinguishes the atoms of one element from the atoms of another.

- The number of protons in the nucleus of an atom is the **atomic number** of that atom.

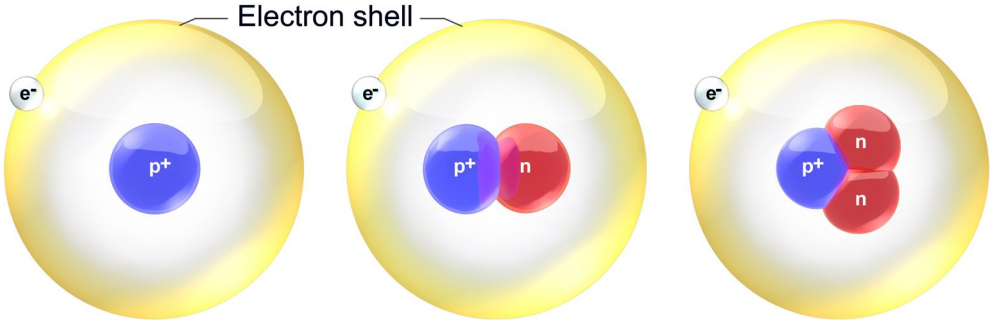


How can we describe atoms?

- The atoms of a certain element always have the same number of protons, but the number of neutrons may differ.

- *Isotopes* are atoms of the same element that have different numbers of neutrons.

- The total number of protons and neutrons in an atom's nucleus is its **mass number**.



Hydrogen-1
mass number: 1

Hydrogen-2, deuterium
mass number: 2

Hydrogen-3, tritium
mass number: 3

Isotopes

Number of Neutrons + Number of Protons = Mass Number

Mass Number

Get Organized!

What are elements?

- It was once believed that fire, wind, earth, and water, in various combinations, made up all objects.

- By the 1860s, scientists considered there to be at least 60 different basic substances, or elements.

- Scientists found that many of these elements have similar properties and began classifying them.

How are the elements organized?

- Dmitri Mendeleev first organized the elements by arranging them in order of increasing atomic mass.

- He observed that the properties of those elements were in a *periodic*, or regularly repeating, pattern.

How are the elements organized?

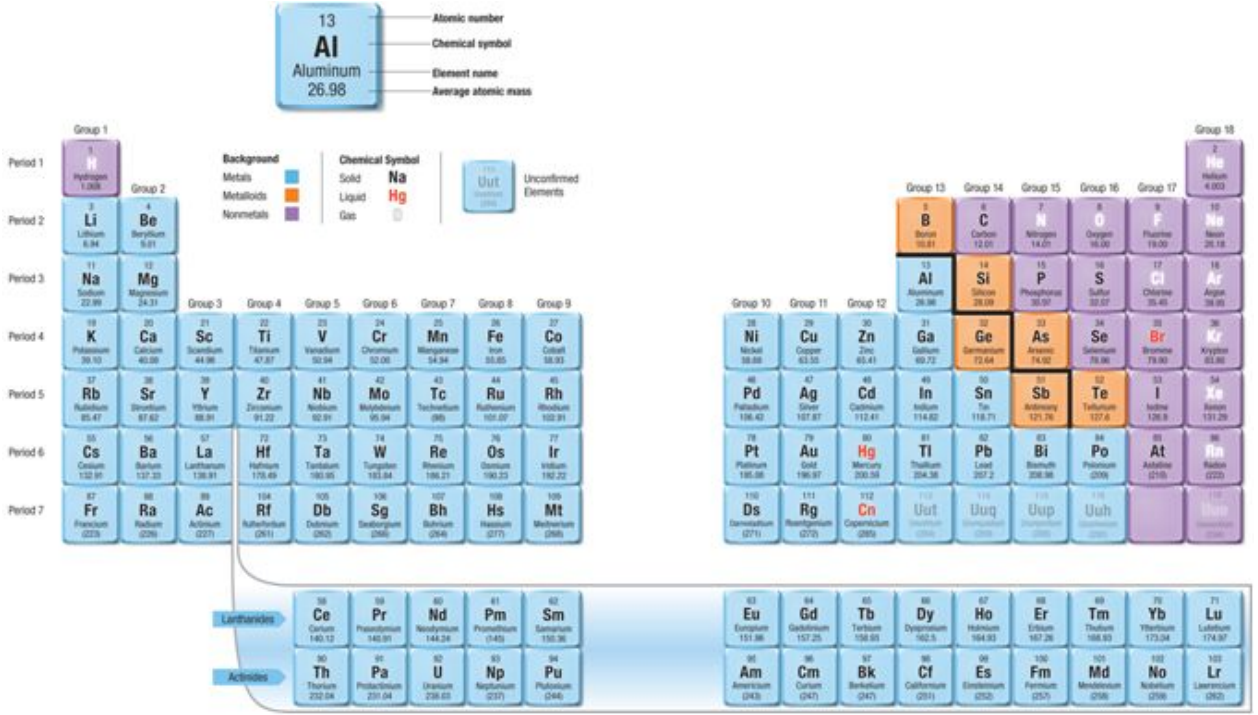
- Mendeleev's arrangement of the elements became known as the **periodic table**.

- Henry Moseley reorganized Mendeleev's periodic table in order of increasing number of protons, or *atomic number.*

- The periodic table is useful because it makes clear many patterns among the elements' properties.

How are the elements organized?

- What can you learn about an element from the periodic table?

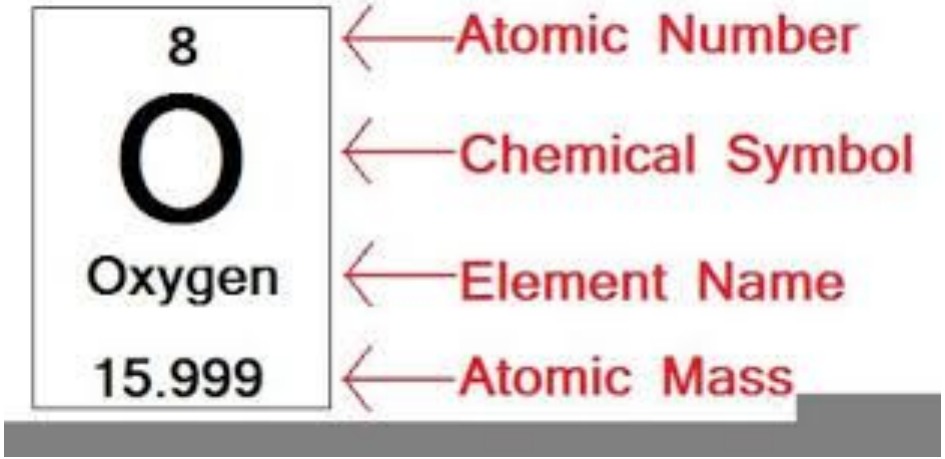


Making Arrangements

What information is contained in each square on the periodic table?

- Each square contains an element's chemical name, atomic number, chemical symbol, and average atomic mass.

- The atomic number is placed at the top of each square.



What information is contained in each square on the periodic table?

- The **chemical symbol** is an abbreviation for the element's name.

- The first letter of the chemical symbol is always capitalized, and any other letter is lowercase.

- The name of the element is written under the symbol.

What information is contained in each square on the periodic table?

- All atoms of an element have the same number of protons, but the number of neutrons can vary.

- The **average atomic mass** of an atom is the weighted average of the masses of all the naturally occurring isotopes of that element.

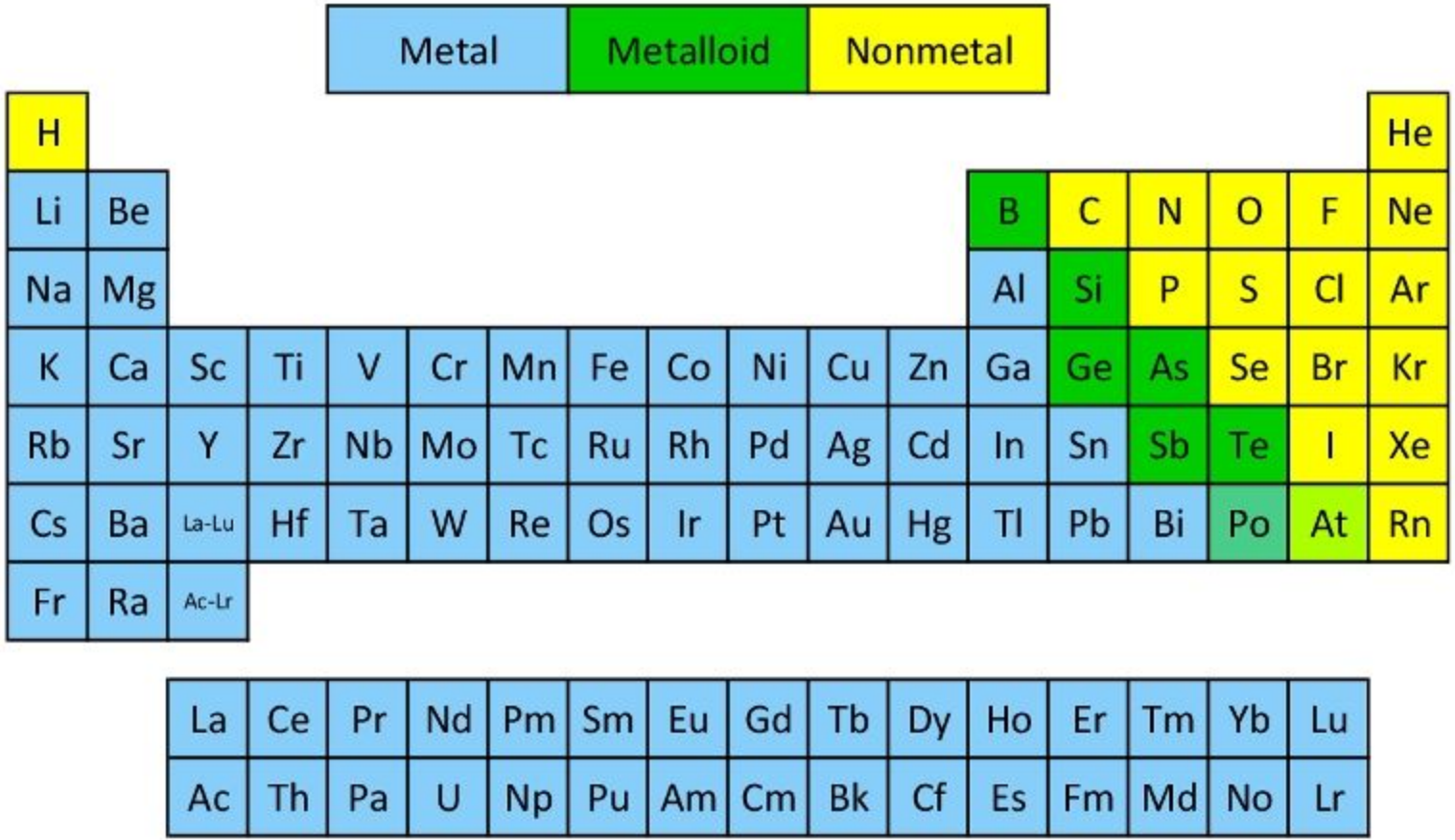
- Average atomic mass is reported in atomic mass units (*u*).

How are the elements arranged on the periodic table?

- A zigzag line on the periodic table divides the three major categories of elements: metals, nonmetals, and metalloids.

- **Metals** are elements that are shiny and conduct heat and electricity well.

- Elements to the left of the zigzag line are metals, except for hydrogen.


Metal
Metalloid
Nonmetal
H
He
Li
Be
B
C
N
O
F
Ne
Na
Mg
Al
Si
P
S
Cl
Ar
K
Ca
Sc
Ti
V
Cr
Mn
Fe
Co
Ni
Cu
Zn
Ga
Ge
As
Se
Br
Kr
Rb
Sr
Y
Zr
Nb
Mo
Tc
Ru
Rh
Pd
Ag
Cd
In
Sn
Sb
Te
I
Xe
Cs
Ba
La-Lu
Hf
Ta
W
Re
Os
Ir
Pt
Au
Hg
Tl
Pb
Bi
Po
At
Rn
Fr
Ra
Ac-Lr
La
Ce
Pr
Nd
Pm
Sm
Eu
Gd
Tb
Dy
Ho
Er
Tm
Yb
Lu
Ac
Th
Pa
U
Np
Pu
Am
Cm
Bk
Cf
Es
Fm
Md
No
Lr

How are the elements arranged on the periodic table?

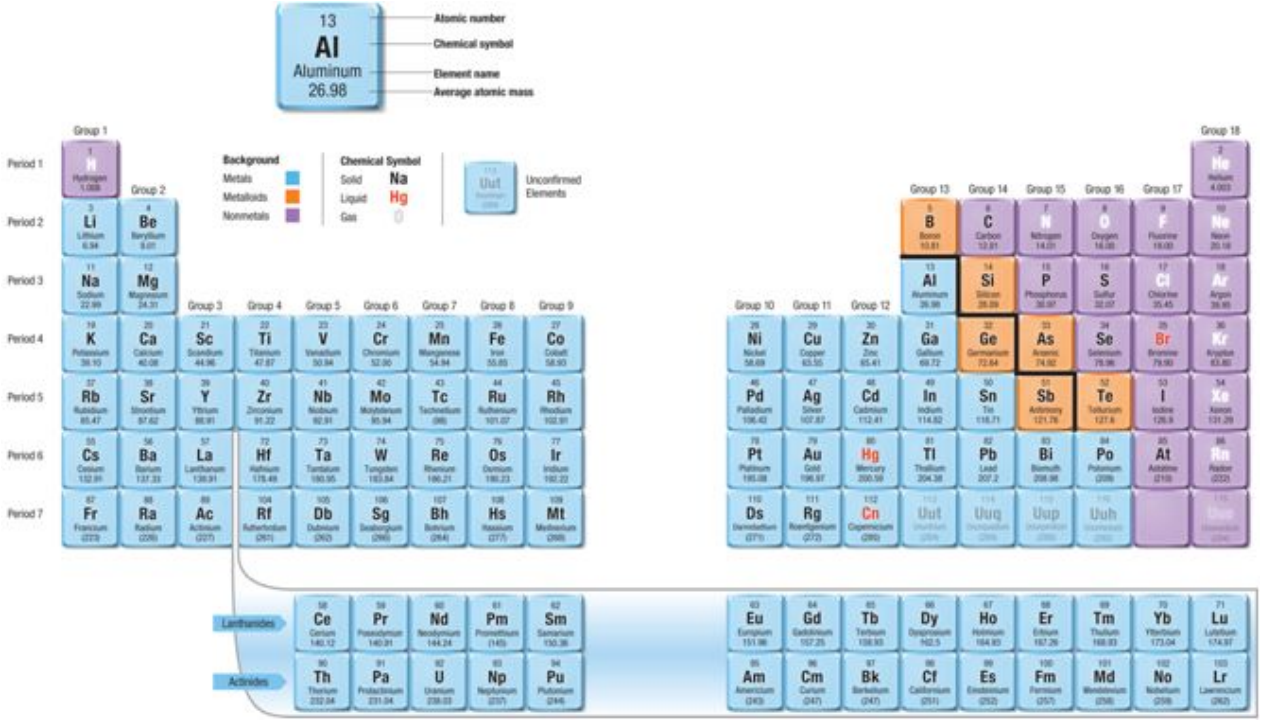
- The elements to the right of the zigzag line are nonmetals.

- **Nonmetals** are poor conductors of heat and electricity, and are often dull and brittle.

- **Metalloids** are elements that have some properties of metals and nonmetals. They border the zigzag line.

How are the elements arranged on the periodic table?

- List three metals, nonmetals, and metalloids.



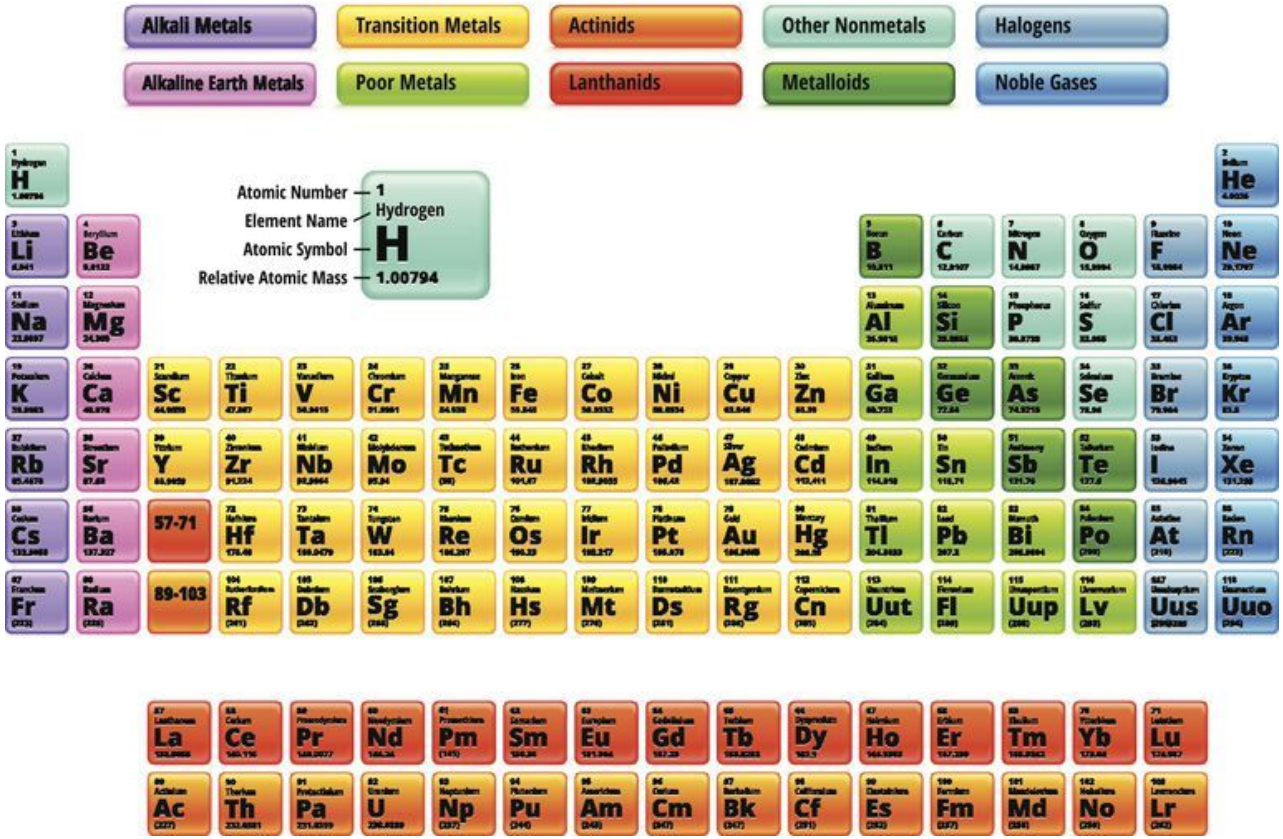
How are the elements arranged on the periodic table?

- Each vertical column of elements on the periodic table is called a **group**, or *family.*

- Elements in a group are similar because their atoms have the same number of *valence electrons.*

- Valence electrons participate in chemical bonding.

Periodic Table of Elements

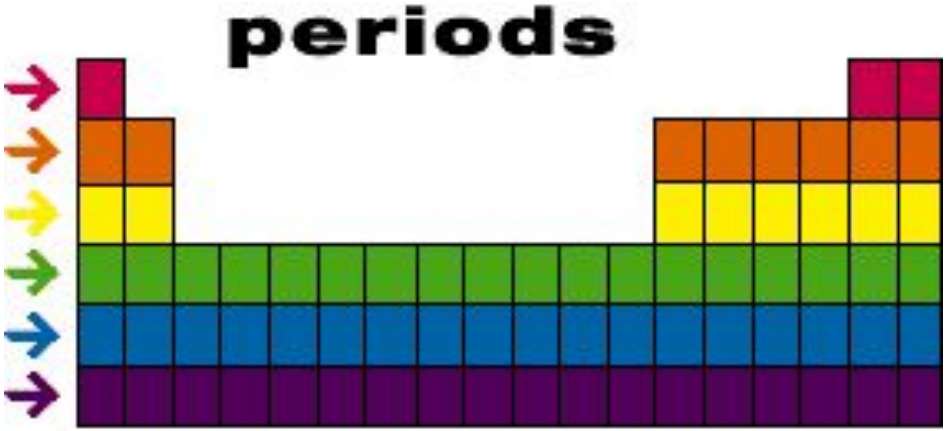


How are the elements arranged on the periodic table?

- Each horizontal row of elements on the periodic table is called a **period**.

- Physical and chemical properties of elements change in predictable ways from one end of the period to the other.

- Atomic size decreases as you move from left to right across a period.



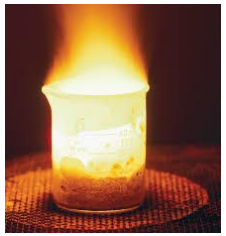
How are the elements arranged on the periodic table?

- Elements in the middle of a period are the most dense.

- As you move from left to right within a period, the atomic number of each element increases by 1.

- The lanthanides and actinides are placed below the table to allow the table to be narrower.

Change It Up!



What are the signs of a chemical reaction?

- A **chemical reaction** is the process in which atoms are rearranged to produce new substances.

- During a chemical reaction, the bonds that hold atoms together may be formed or broken.

- The properties of the substances produced in a chemical reaction differ from the properties of the original substances.

What are the signs of a chemical reaction?

- A change in properties is a sign that a chemical reaction may have happened.

- For example, a solid substance called a *precipitate* may form in a solution.

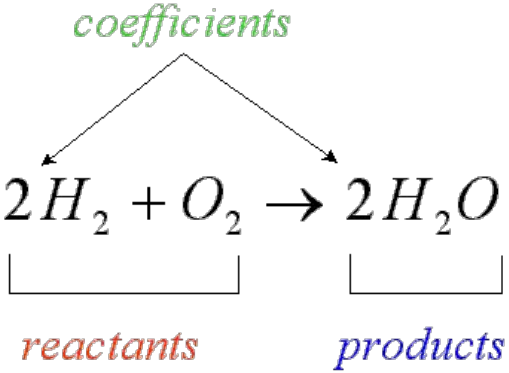
- A color change, a change in odor, the formation of a precipitate, and the appearance of gas bubbles are all evidence of a chemical reaction.

How are chemical reactions modeled?

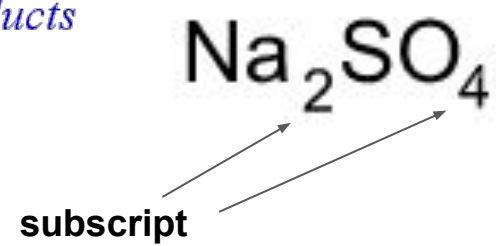
- A **chemical formula** uses chemical symbols and numbers to represent a given substance.

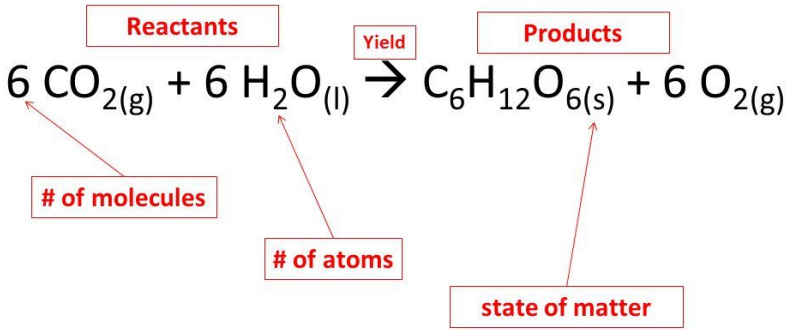
- The chemical symbols in a chemical formula tell you what elements make up a substance.

- The numbers written below and to the right of chemical symbols are called *subscripts*. Subscripts tell you how many of each type of atom are in a molecule.



Chemical Equations





Subscripts show how many atoms:

Na = 2

S = 1

O = 4

How are chemical reactions modeled?

- To model reactions, chemical formulas can be joined together in an equation.

- A **chemical equation** is an expression that uses symbols to show the relationship between the starting substances and the substances that are produced by a chemical reaction.

How are chemical reactions modeled?

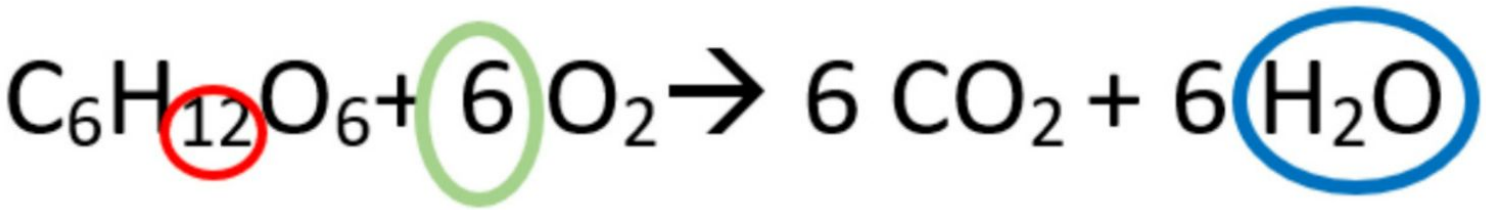
•**Reactants** are the substances that participate in a chemical reaction. Their chemical formulas are written on the left of a chemical equation.

•**Products** are the substances formed in a reaction. Their chemical formulas are written on the right of a chemical equation.

•An arrow known as a *yields sign* points from reactants to products. Plus signs separate the chemical formulas of multiple products or reactants.

Reactants yields Products

glucose oxygen carbon dioxide water



subscript coefficient formula

How are chemical reactions modeled?

$$C + O_2 \qquad CO_2$$

- Identify the reactant(s) and the product(s) in the above chemical reaction.

- The atoms of which elements participate in this reaction?

A Balancing Act

How do chemical equations show the law of conservation of mass?

- The **law of conservation of mass** states that matter is neither created nor destroyed in ordinary physical and chemical changes.

- This law means that a chemical equation must show the same numbers and kinds of atoms on both sides of the arrow.

How do chemical equations show the law of conservation of mass?

$$2C + O_2 \qquad 2CO$$

- A *coefficient* is a number placed in front of a chemical formula. Use coefficients to balance a chemical equation.

- **Only coefficients**—not subscripts—**can be changed when balancing equations.**

- This chemical equation shows two carbon atoms and two oxygen atoms on each side of the arrow.

Energy, Energy

What happens to energy during chemical reactions?

- Chemical reactions can either release energy or absorb energy.

- A chemical reaction that requires an input of energy is called an **endothermic reaction**. The energy is absorbed from the surroundings, usually as heat.

- A chemical reaction in which energy is released to the surroundings is called an **exothermic reaction**.

Endothermic v. Exothermic

	Exothermic	Endothermic
Diagram		
Definition	A reaction that **releases energy to the surroundings**, causing the reaction mixture and its surroundings to become **hotter**	A reaction in which **energy is absorbed from the surroundings**, causing the reaction mixture and its surroundings to become **cooler.**
Examples	Burning/combustion, neutralisation and displacement	Evaporation or melting

*Some reactions can be either exothermic or endothermic—like dissolving a salt in water or a precipitation reaction

What happens to energy during chemical reactions?

- The **law of conservation of energy** states that energy cannot be created or destroyed.

- However, energy can change form.

- The total amount of all of the types of energy is the same before and after every chemical reaction.

The Need for Speed

What affects the rates of reactions?

- The rate of a reaction describes how quickly the reaction occurs.

- For a reaction to occur, particles of the reactants must collide. Reaction rates are affected by how often the particles collide.

- Factors that affect reaction rates include concentration, surface area, temperature, and the presence of a catalyst.

What affects the rates of reactions?

- At higher concentrations, there are more reactants in a given volume, so the particles are more likely to collide and react.

- The reaction rate is higher when reactant concentration is higher.

- Crushing or grinding solids increases their surface area and the reaction rate, as more reactant particles are exposed to one another.

What affects the rates of reactions?

- Reactions usually occur more quickly at higher temperatures. The reactant particles move more quickly, so they are more likely to collide and react.

- A catalyst is a substance that changes the rate of a chemical reaction without being used up or changed very much.

What affects the rates of reactions?

- Catalysts can increase reaction rate by bringing reactants together.

Enzymes

- Enzymes that increase the rates of reactions keep your body going. They help digest food to give energy to the body, and they help build the molecules the body needs to grow.

- Problems with enzymes can cause medical conditions or changes in the body.

- The enzymes in some cleaners help break down substances such as grease.