

Matter and Energy

Objectives

- ❑ Describe the characteristics of solids, liquids, and gases.
 - ❑ Classify a sample of matter as an element, compound, or mixture.
 - ❑ Given the name of one of the 48 common elements, write the symbol.
 - ❑ Given the symbol for one of the 48 common elements, write the name.
 - ❑ Classify an element as a metal or a nonmetal.
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Objectives

- ❑ Predict whether an element is a metal, nonmetal, or semimetal given its position in the periodic table.
 - ❑ Predict whether an element is a solid, liquid, or gas at 25 °C and normal atmospheric pressure.
 - ❑ Given the chemical formula for a compound, state the number of atoms of each element in the compound.
 - ❑ Classify a property of a substance as physical or chemical.
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Objectives

- ❑ Classify a change in a substance as physical or chemical.
 - ❑ List observations that indicate a chemical change is occurring.
 - ❑ Apply the conservation of mass law to chemical changes.
 - ❑ Apply the conservation of energy law to physical and chemical changes.
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The Solid State

- Fixed Shape
 - Definite Volume
 - Tightly packed particles
 - Incompressible
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The Liquid state

- Variable Shape
 - Definite Volume
 - Loosely Packed Particles
 - Only Slightly Compressible
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The Gaseous State

- Variable Shape
 - Indefinite Volume
 - Widely Spaced Particles
 - Compressible
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Changes of State

- ❑ Melting - Changing from a solid to a liquid.
 - ❑ Freezing - Changing from a liquid to a solid.
 - ❑ Vaporization - Changing from a liquid to a gas.
 - ❑ Condensation - Changing from a gas to a liquid.
 - ❑ Sublimation - Changing from a solid to a gas.
 - ❑ Deposition - Changing from a gas to a solid.
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Examples of Changes of State

- ❑ Melting - Ice changing from a solid to a liquid.
 - ❑ Deposition - Iodine changing from a gas to a solid.
 - ❑ Freezing - Sulfur changing from a liquid to a solid.
 - ❑ Vaporization - Alcohol changing from a liquid to a gas.
 - ❑ Sublimation - Dry ice changing from a solid to a gas.
 - ❑ Condensation - Natural gas changing from a gas to a liquid.
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Classifying Matter

- Heterogeneous Matter - Matter that has properties that vary widely from one place to another. Heterogeneous matter can be separated into two or more homogeneous substances by physical means.
 - Heterogeneous Mixture
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Classifying Matter

- Homogeneous Matter - Matter in which the composition is uniform throughout.
 - Homogeneous Mixture
 - Solution - A homogeneous mixture consisting of a solid, liquid, or gas dissolved in another solid, liquid, or gas.
 - Alloy - A homogeneous mixture of two metals.
 - Pure Substance - Matter that has a definite composition and consistent properties.
 - Compound - Matter that can be separated into two or more substances by chemical means.
 - Element - Matter that cannot be broken down further by any chemical change.
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Common Chemical Elements

- Oxygen
 - Silicon
 - Aluminum
 - Iron
 - Nickel
 - Calcium
 - Sodium
 - Potassium
 - Magnesium
 - Hydrogen
 - Carbon
 - Nitrogen
 - Chlorine
 - Gold
 - Silver
 - Helium
 - Iodine
 - Lead
 - Mercury
 - Phosphorus
 - Sulfur
 - Zinc
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Chemical Symbols

□ First letter of the name, always capitalized.

■ Carbon C

■ Hydrogen H

■ Oxygen O

□ First letter and another letter, first letter capitalized, second letter lower case.

■ Helium He

■ Magnesium Mg

■ Chlorine Cl

Chemical Symbols

□ Symbol derived from the Latin name.

■ Lead Plumbum Pb

■ Gold Aurum Au

■ Silver Argentum Ag

■ Iron Ferrum Fe

Classifying Elements

□ Metal

- Bright metallic luster
 - High density
 - High melting point
 - Good conductor of heat and electricity.
 - Malleable
 - Ductile
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Classifying Elements

- Nonmetal
 - Dull appearance
 - Low density
 - Low melting point
 - Poor conductor of heat and electricity
 - Neither malleable nor ductile
 - Semimetal or metalloid - Properties between a metal and a nonmetal.
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The Periodic Table

- ❑ Lists all known elements arranged by atomic number.
 - ❑ Metals are on the left, nonmetals are on the right, and metalloids are in the middle.
 - ❑ Except for mercury, all metals and metalloids are solids at room temperature.
 - ❑ Nonmetals are found in all three states at room temperature.
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Chemical Formulas

- Law of Definite Proportions -
Compounds always contain the same elements in a consistent proportion by mass.
 - NaCl - 39.3% sodium, 60.7% chlorine
 - H₂O - 11.2% hydrogen, 88.8% oxygen
 - Chemical Formula - A chemical formula expresses the number of atoms of each element in a compound with a subscript.
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Chemical Formula Examples

- H_2O - Two atoms of hydrogen, one atom of oxygen
 - NaCl - One atom of sodium, one atom of chlorine
 - CO_2 - One atom of carbon, two atoms of oxygen.
 - $\text{Al}_2(\text{SO}_4)_3$ - Two atoms of aluminum, three atoms of sulfur, 12 atoms of oxygen
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Physical and Chemical Properties

- Physical Properties - Characteristics of a substance that can be observed without changing the composition of the substance.
 - Appearance
 - Melting and boiling points
 - Density
 - Conductivity
 - Solubility
 - Physical State
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Physical and Chemical Properties

- Chemical Properties - Properties that can be observed only when a substance reacts chemically with another substance.
 - Reaction with oxygen
 - Reaction with water
 - Reaction with acid
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Physical and Chemical Change

- Physical Change - A change in which the composition of the substance does not change.
 - Melting ice
 - Evaporating alcohol
 - Crushing an aluminum can
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Physical and Chemical Change

- Chemical Change - A change in which the chemical composition of the substance is altered leading to a new set of properties.
 - A banana ripening
 - An antacid tablet fizzing
 - Fireworks exploding
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Physical and Chemical Change

- Indications of chemical change:
 - Permanent change in color
 - An odor
 - Bubbles resulting from the release of a gas
 - Heat
 - Light
 - Production of an insoluble substance when two solutions are mixed.
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Conservation of Mass

- During any chemical reaction, mass is neither created nor destroyed.
 - Electrolysis: 27 g of H_2O yields 3 g of hydrogen and 24 g of oxygen.
 - Burning Magnesium: 2.43 g Mg and 1.60 g O yield 4.03 g MgO
 - Combining zinc and sulfur: .654 g Zn and .321 g S yield .975 g ZnS
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Energy

- ❑ Kinetic Energy - Energy associated with the overall motion of an object.
 - ❑ Gravitational Potential Energy - energy associated with the position of an object relative to the earth.
 - ❑ Chemical Potential Energy - Energy associated with the chemical composition of a substance.
 - ❑ Thermal Energy - Energy associated with the motion of the atoms and molecules of a substance.
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- An increase in thermal energy might:
 - Cause an increase in temperature.
 - Cause a substance to melt.
 - Cause a substance to vaporize.
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Conservation of Energy

- The Law of Conservation of Energy - Energy cannot be created or destroyed. It can only be converted from one form to another.
 - Conservation of Energy during physical changes:
 - Water boiling
 - Energy of crystallization
 - Conservation of Energy during chemical changes:
 - $2\text{H}_2 + 2\text{O}_2$ yields $2\text{H}_2\text{O} + 3200$ cal
 - Cold pack reaction
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