

AMSAT CHEM 1H TOPIC#3

MATTER & CHANGE NOTES

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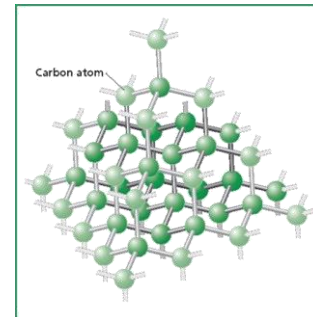
WHAT IS CHEMISTRY? SECTION#1

- It is the study of the composition, structure, and properties of matter and the changes (Δ 's) it undergoes. It is a central science (overlaps many other sciences).
- Instruments
 - Used to observe and make measurements (microscopic and macroscopic)
- Branches
 - Organic chemistry
 - Study of most carbon (C) containing compounds
 - Inorganic chemistry
 - Study of all substances not considered organic
 - Physical chemistry
 - Study of properties and changes of matter and their relation to energy
 - Analytical chemistry
 - Identification of the components and composition of materials
 - Biochemistry
 - Substances and processes occurring in living things
 - Theoretical Chemistry
 - Use of models to understand chemical behavior and to predict the properties of new compounds
- Chemical
 - Any substance that has a definite composition – NaCl (salt), H₂O (water), or gold (Au).
- Basic research
 - Research done for an increase in basic knowledge. How and why a reaction (rxn) occurred and what are the properties.
- Applied research
 - Research carried out to solve a specific problem (ozone depletion).
- Technological development
 - Production and use of products to better the quality of life
 - Basic discoveries can lead to new technologies
 - R. Plunkett discovered Teflon by accident while working on basic research on organic compounds.
 - Michael Faraday worked with electricity and his basic research led to the invention of electric motors.

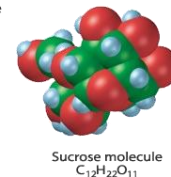
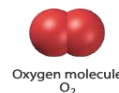
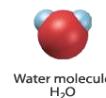
MATTER AND ITS PROPERTIES SECTION #2

- Matter
 - Has mass and volume
 - Mass
 - the measure of the amount of matter in an object
 - Volume
 - the space matter occupies
 - Is it possible to have a mass and no volume?
 - Is it possible to have a volume and no mass?

- Basic building blocks
 - Element
 - Pure substance cannot be broken down by chemical means (reactions, heat, etc.)
 - Made of one type of atom
 - Gold – Au
 - Platinum – Pt
 - Atom
 - smallest unit of an element (retains chemical properties of the element)



- Compound
 - Substance made of atoms chemically combined
 - Water is made from 2 parts hydrogen (H) and 1 part oxygen (O)
 - H₂O



- Properties and Changes in Matter
 - Properties
 - Extensive Properties
 - Depend on the amount of matter
 - Volume, mass, and amount of energy
 - Intensive Properties
 - Do not depend on the amount of matter
 - Density, melting point (mp), boiling point (bp), ability to conduct heat/electricity
 - **Sample Problem 2.1** – Extensive/Intensive Properties
Identify each as intensive (I) or extensive (E).
 - (1) A piece of wood has a mass of 1000 grams. _____
 - (2) Water has a heat capacity of 4.184J _____
 - (3) Ice has a density of 0.91g/cm³. _____
 - (4) I traveled 300 miles on a tank of gas. _____

| Rank | Name | Formula | Uses |
|------|-----------------------------|---|--|
| 1 | sulfuric acid | H ₂ SO ₄ | production of fertilizer; metal processing; petroleum refining |
| 2 | ethene | C ₂ H ₄ | production of plastics; ripening of fruits |
| 3 | propylene | C ₃ H ₆ | production of plastics |
| 4 | ammonia | NH ₃ | production of fertilizer; refrigeration |
| 5 | chlorine | Cl ₂ | bleaching fabrics; purifying water; disinfectant |
| 6 | phosphoric acid (anhydrous) | P ₂ O ₅ | production of fertilizer; flavoring agent; rustproofing metals |
| 7 | sodium hydroxide | NaOH | petroleum refining; production of plastics |
| 8 | 1,2-dichloroethene | C ₂ H ₂ Cl ₂ | solvent, particularly for rubber |

Physical Properties

- A property observed without changing identity of substance
 - mp, bp, fp, density
 - solubility
 - ability to dissolve in a solvent
 - a physical property

| Property | Description | Example |
|-------------------------|---|---|
| Electrical conductivity | ability to carry electricity | Copper is a good electrical conductor, so it is used in wiring. |
| Heat conductivity | ability to transfer energy as heat | Aluminum is a good heat conductor, so it is used to make pots and pans. |
| Density | mass-to-volume ratio of a substance; measure of how tightly matter is "packed" | Lead is a very dense material, so it is used to make sinkers for fishing line. |
| Melting point | temperature at which a solid changes state to become a liquid | Ice melts to liquid water at the melting point of water. |
| Boiling point | temperature at which a liquid boils and changes state to become a gas at a given pressure | Liquid water becomes water vapor at the boiling point of water. |
| Index of refraction | extent to which a given material bends light passing through it | The index of refraction of water tells you how much light slows and bends as it passes through water. |
| Malleability | ability to be hammered or beaten into thin sheets | Silver is quite malleable, so it is used to make jewelry. |
| Ductility | ability to be drawn into a thin wire | Tantalum is a ductile metal, so it is used to make fine dental tools. |

- substance is not changed
- just broken down into smaller pieces

Chemical Properties

- Substances ability to transform into different substances
 - flammability, reactivity

Sample Problem 2.2 – Physical vs. Chemical Property

Identify each as a physical (P) or chemical (C) property.

- (1) Paper ignites at 451°F. _____
- (2) Salt dissolves in water. _____
- (3) Iron rusts when in contact with water. _____
- (4) Silver is a good conductor of electricity. _____
- (5) Sodium reacts violently with water. _____
- (6) Healthy leaves reflect green light. _____

Changes

- Changes
 - All changes require energy (Joules (J))
 - Needs energy or input of energy
 - Endothermic
 - Absorbs energy (+ ΔE)
 - Gives energy or releases energy
 - Exothermic
 - Releases energy (- ΔE)

- Physical Changes (Δ)

- Law of Conservation of Mass
 - In a chemical reaction, mass cannot be lost/gained



a When acetic acid, in vinegar, and sodium hydrogen carbonate, or baking soda, are mixed, the solution bubbles as carbon dioxide forms.



b When solutions of sodium sulfide and cadmium nitrate are mixed, cadmium sulfide, a solid precipitate, forms.



c When aluminum reacts with iron(III) oxide in the clay pot, energy is released as heat and light.



d When phenolphthalein is added to ammonia dissolved in water, a color change from colorless to pink occurs.

▪ **Sample Problem 2.5** – Physical/Chemical Change

Identify each as a physical (P) or chemical (C) change.

- (1) Paper burning. _____
- (2) Kool-Aid dissolving in water. _____
- (3) Milk souring. _____
- (4) Wood rotting. _____
- (5) A glass of water evaporating. _____

- Law of Conservation of Matter
 - Matter is neither created nor destroyed in any process
 - Antoine Lavoisier

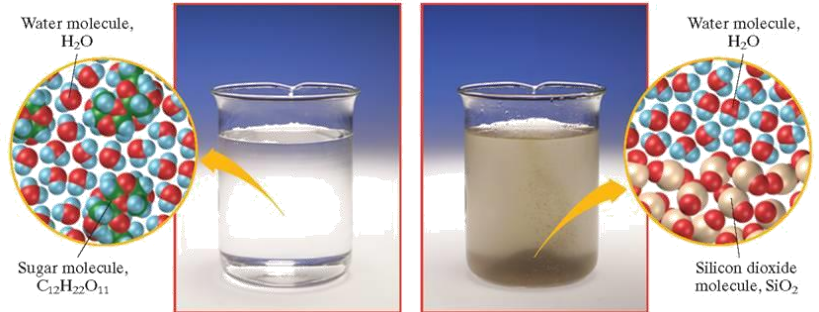
● Classification of Matter

- Need a method for grouping matter according to similar characteristics
- 4 Types of Matter
 - Mixtures (2 types)
 - A blend of two or more kinds of matter
 - Each part retains its own identity and characteristics
 - Homogeneous Mixture (Solutions)
 - Uniform in composition
 - Same proportion of components throughout
 - Do not separate out, always stay mixed
 - solvent
 - greater part
 - does the dissolving
 - Solute
 - smaller part
 - dissolved by solvent
 - Heterogeneous
 - Easily discernable parts
 - Separates out, need to remix

- Not uniform
 - Clay and water mixture
 - Clay will settle out over time
- Separation Techniques for Mixtures
 - Filtration – filtering solid from a liquid
 - Chromatography – flowing along a stationary substance
 - Distillation – differences in boiling points
 - Fractional distillation
 - Centrifugation – spinning to separate
 - Crystallization – evaporation of solvent

- Pure substances (2 types)

- Has a fixed composition and differs from mixtures in the following ways:



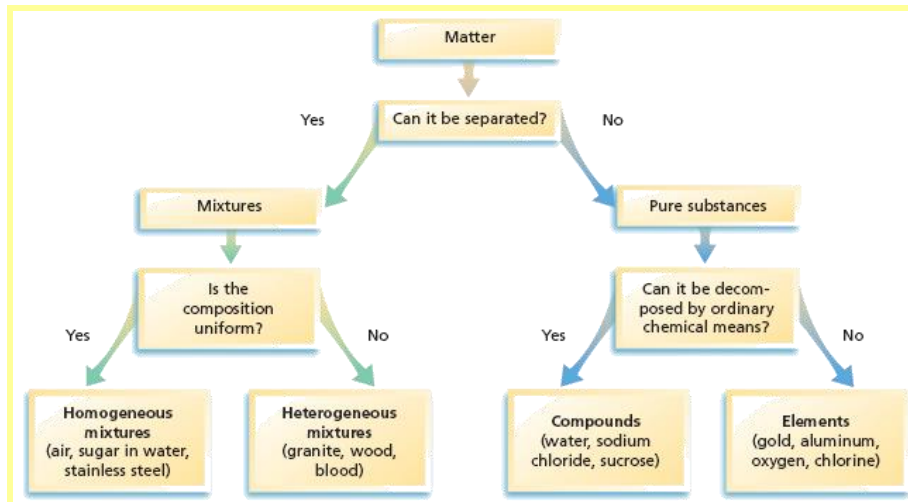
- (1) Every sample has the exact same characteristics

- Same physical and chemical properties
 - So specific they can be used to identify the substance

- (2) Every sample has exactly the same composition.

- Same makeup
 - For example, water is always made up of 11.2% hydrogen and 88.8% oxygen by mass.
 - Law of Definite Composition
 - A pure substance always has the same percentage of components by mass.

- Elements and compounds
 - The two types of pure matter



- **Sample Problems 2.6** – Identifying Type of Matter
Identify the type of matter for each of the following. (HM) homogeneous mixture, (HT) heterogeneous mixture, or (P) pure.

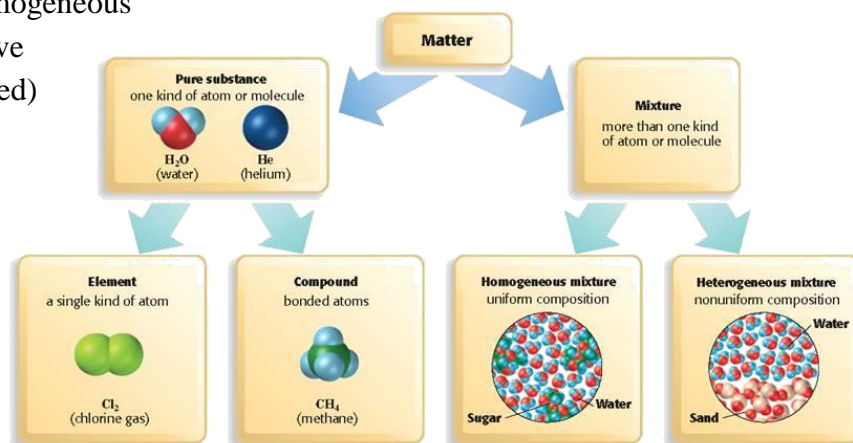
- | | | | |
|------------------------|-------|---------------------------|-------|
| (1) supreme pizza | _____ | (5) bleach | _____ |
| (2) milk chocolate bar | _____ | (6) Windex window cleaner | _____ |
| (3) open can of Coke | _____ | (7) water | _____ |
| (4) vinegar | _____ | (8) sugar | _____ |

- 3 types of matter are homogeneous

- Meaning they have uniform (organized) composition

- 1 type of matter is heterogeneous

- Meaning it not uniform (unorganized)



- Chemical purity

- Chemical

- Any type of matter with definitive composition

- Water, NaCl, 3.0 M soln of FeCl₃, etc.

- In this class we will consider all chemicals as pure.



| | |
|----------------------------------|--|
| Increasing purity | Primary standard reagents |
| | ACS (American Chemical Society–specified reagents) |
| | USP (United States Pharmacopoeia standards) |
| | CP (chemically pure; purer than technical grade) |
| | NF (National Formulary specifications) |
| | FCC (Food Chemical Code specifications) |
| Technical (industrial chemicals) | |

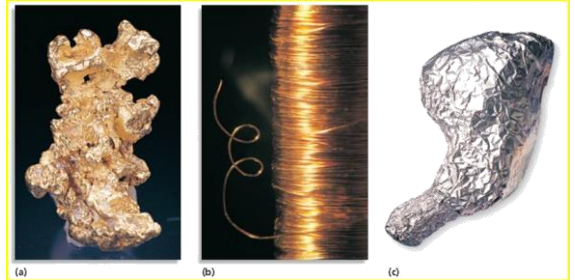
ELEMENTS SECTION #3

- Element – simplest form of matter
 - All are organized on the Periodic Table of Elements
 - Organized by ascending atomic number
 - Basic information in periodic table square
 - Atomic number, atomic elemental symbol, atomic mass
 - Periodic table
 - Columns – groups or families (Up/down)
 - 18 groups
 - Have similar chemical/physical properties

- Group 2 elements (Alkaline Earth Metals)
 - beryllium(Be), magnesium(Mg), calcium(Ca), strontium(Sr), barium(Ba), and radium(Ra)
 - All form 2+ cations, reactive metals
- Rows – periods or energy levels (left to right)
 - 7 periods (rows)
 - Physical/chemical properties change across the period
 - Elements close together in a period are more similar than ones far apart
 - Lithium and beryllium have similar props but very dissimilar with fluorine
- 3 types of elements

- Metals – most of periodic table (left side)

- Malleable – sheets
- Ductile – wires
- Conducts
 - Heat
 - Electricity (sea of electrons)
- Luster – shines
- Loses electrons to form cations (positive ions)
 - Copper (Cu)
 - Reddish color, lustrous
 - Wire, sheets, conducts heat & electricity, forms Cu^{2+} & Cu^{1+} cations

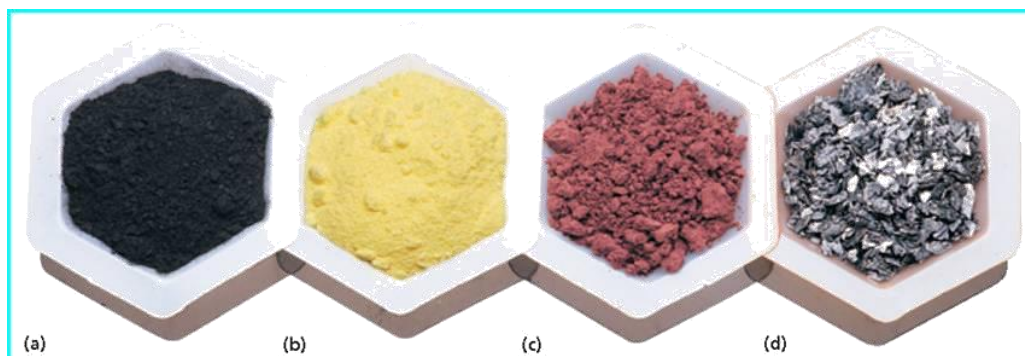


- Metalloids (semiconductors)

- Exhibit properties between metals and nonmetals
 - boron(B), silicon (Si), germanium (Ge), arsenic (As), antimony (Sb), tellurium (Te)

- Nonmetals

- Most are gases at room temperature (T)
- Nonconductors – do not conduct heat, electricity
- Gains electrons to form anions (negative ions)
 - Phosphorus
 - Gains 3 electrons to form the P^{3-} anion



(a) carbon (C)

(b) sulfur (S)

(c) phosphorus (P)

(d) iodine (I)

- Noble gases
 - Helium(He), Neon(Ne), Argon(Ar), Krypton(Kr), Xenon (Xe), and Radon (Rn)
 - Group 18
 - Inert (unreactive)
 - Full octet (8 electrons (e^-) in outer electron shell)
 - Gases at room temperature

| Elements with Symbols Based on Older Names | | |
|---|---------------|-------------------|
| Modern Name | Symbol | Older Name |
| antimony | Sb | stibium |
| copper | Cu | cuprum |
| gold | Au | aurum |
| iron | Fe | ferrum |
| lead | Pb | plumbum |
| mercury | Hg | hydrargyrum |
| potassium | K | kalium |
| silver | Ag | argentum |
| sodium | Na | natrium |
| tin | Sn | stannum |
| tungsten | W | wolfram |

▪ **Sample Problem 2.7** – Types of Elements

Identify the following elements as either a metal (m), nonmetal (nm), or metalloid (ml).

- | | | | |
|--------------|-------|----------------|-------|
| (1) sodium | _____ | (6) molybdenum | _____ |
| (2) fluorine | _____ | (7) selenium | _____ |
| (3) neon | _____ | (8) antimony | _____ |
| (4) silicon | _____ | (9) bismuth | _____ |
| (5) arsenic | _____ | (10) tungsten | _____ |

Types of Elements Activity

Pick four colors.

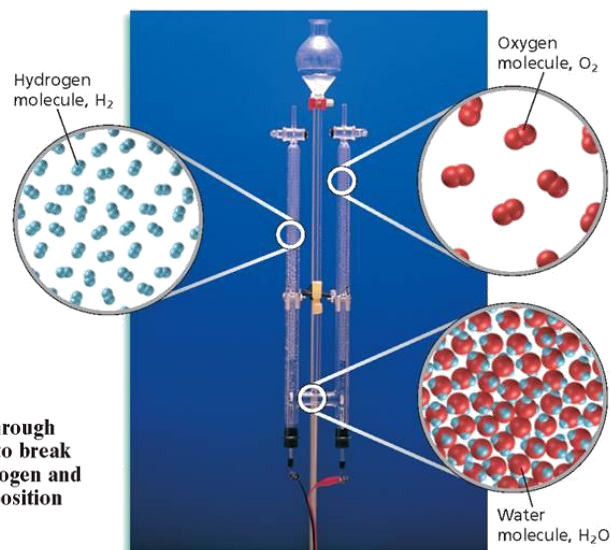
Create a key for metals, metalloids, nonmetals, and noble gases.

Color the metalloids. Color noble gases. Color nonmetals. Color metals. Leave hydrogen uncolored.

• Compounds

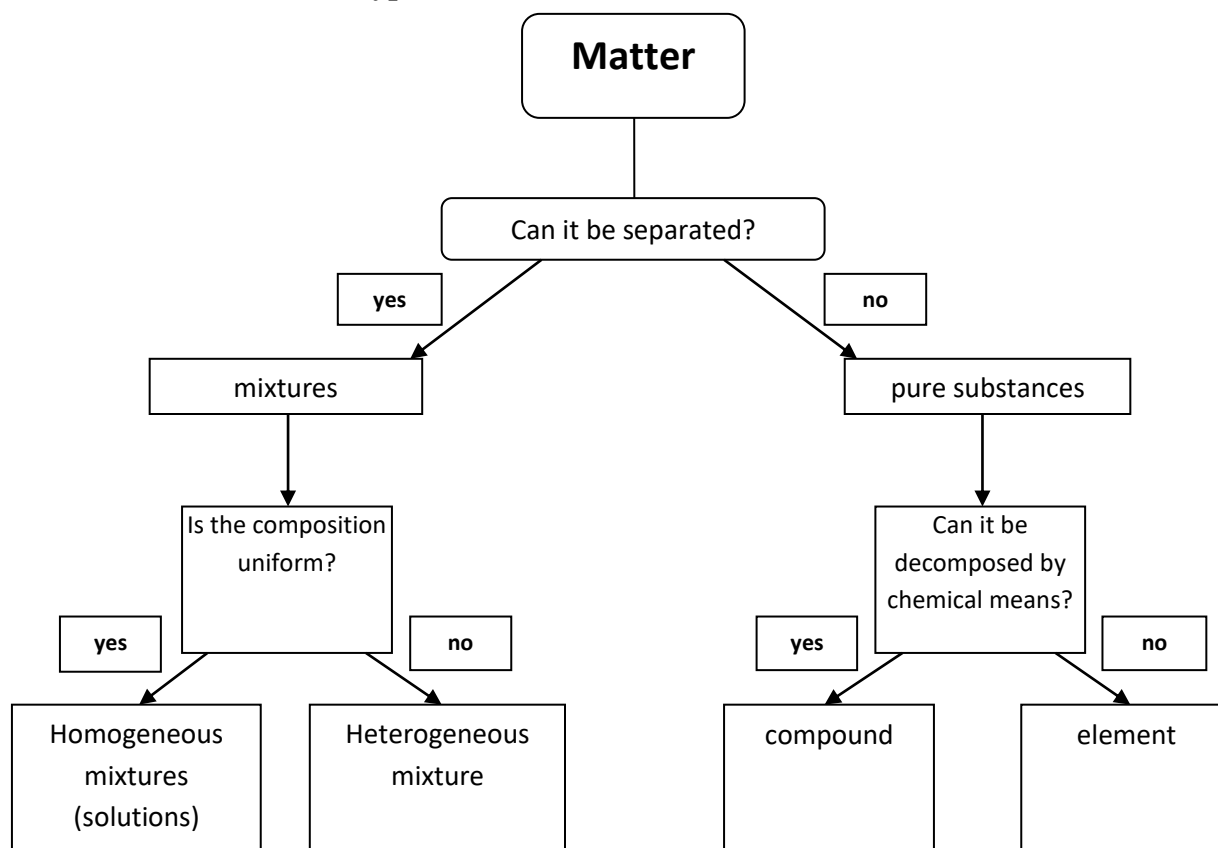
○ Molecule

- Smallest unit with properties of compound
- Two or more chemically combined elements
 - H_2O , $C_6H_{12}O_6$
 - Can be broken down into simpler substances by chemical means
 - Electrolysis (electricity)



Passing an electric current through water causes the compound to break down into the elements hydrogen and oxygen, which differ in composition from water.

Type of Matter Dichotomous Flow Chart



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