Matter

I. Chemistry - the study of the composition, structure, and properties of matter, the changes matter undergoes and the energy accompanying these changes.
- A. Branches of Chemistry
  1. Organic Chemistry – study of carbon – hydrogen containing compounds
  2. Inorganic Chemistry – study of noncarbon compounds
  3. Physical Chemistry – study of the properties and changes of matter and their relation to energy
  4. Analytical Chemistry – identification of the components and composition of materials
  5. Biochemistry – study of substances and processes occurring in living things
  6. Theoretical Chemistry – use of mathematics and computers to understand the principles behind observed chemical behavior and to design and predict the properties of new compounds.

II. Matter - anything that has mass and takes up space (volume)
- A. Pure Substance - homogeneous matter having identical properties and composition.
  1. Element - composed of only atoms of the same atomic number
     a. cannot be decomposed by chemical means
  2. Compound - two or more different elements chemically combined in a definite ratio by weight (using atomic mass)
     a. chemical and physical properties are different than the elements that make up the compound
     b. can be made from simpler substances
     c. can be decomposed into its separate elements
        1. Binary Compound - contains 2 types of elements
        2. Ternary Compound - contains 3 types of elements
- B. Mixtures - combinations of varying amounts of 2 or more distinct substances
  1. Homogeneous Mixture - uniform intermixture of particles when one substance dissolves in another (solution)
     a. gas in gas - air
     b. solid in liquid - salt in water
     c. solid in solid - an allow such as brass (copper & zinc)
     d. liquid in liquid - alcohol in water
  2. Heterogeneous Mixture - have uniformly dispersed ingredients
     a. concrete
     b. sand and water
     c. oil and water

III. Properties - a definite set of characteristics by which a substance can be identified.
  1. can be observed by examining the substance
  2. Determined by the manner in which it behaves when in contact with other substances or sources of energy.
- A. Extensive Properties - depend upon the quantity of a substance present
  1. volume, weight, mass
- B. Intensive Properties - do not depend on size
  1. melting point, boiling point, density,
- C. Physical Properties - characteristics which can be observed without producing new substances

1. Physical change - no new substance is formed but changes of phase may occur.
    a. Ex. Grinding, freezing, boiling
2. Phases of Matter
    a. Solid – definite volume and definite shape
    b. Liquid – definite volume but and indefinite shape (takes shape of container)
    c. Gas – no definite shape or volume (completely fills any container)
    d. Plasma – high temperature physical state of matter in which atoms lose their electrons

D. Chemical Properties - describe how a substance interacts (or not) with other substances
1. Chemical change (reaction) - results in the production of 1 or more new substances
    a. rusting of iron, burning paper

E. Changes in Energy - occur in both physical and chemical changes
1. can be either absorbed or released

F. Law of Conservation of Matter or Mass (Lavoisier) - matter cannot be created or destroyed by a chemical change

IV. Physical Phases (states) of Matter
A. Solid - the substance is relatively rigid and has a definite volume and shape
1. must have a "precise" temperature at which it melts
2. particles are in a fixed position with little space between them
    a. these particles (atoms or molecules) are vibrating)

B. Liquid - a substance has a definite volume, but its shape changes by flowing
1. Particles are considered to vibrate and rotate
    a. Ex. glass becomes softer as it is heated & flows, but does not change phase- glass is considered a liquid with a high viscosity
    b. Viscosity - resistance of a liquid to flow

C. Gas - a substance has no definite volume nor shape and has little response to gravity
1. Particles are considered to vibrate, rotate and translate
    a. Translating – particles break intermolecular bonds allowing for random motion

D. Plasma – a high temperature state in which atoms lose their electrons

V. Introduction to the Periodic Table
A. Groups – columns on the periodic table
1. elements in a group have similar properties
    a. Group I – alkali metals
    b. Group II – alkaline earth metals
    c. Group 4-11 – transition metals
    d. Group 17 – halogens
    e. Group 18 – noble gases

B. Periods – horizontal rows of elements on the periodic table

C. Metals – left side of the periodic table up to the staircase
1. Column 1 – alkali metals
2. Column 2 – alkaline earth metals

D. Metalloids (Semi-metals) – elements on the staircase and germanium (Ge) and antimony (Sb) under it.
1. Staircase starts under Boron
2. metalloids most common ion charge is negative, then positive when combined with nonmetals

E. Nonmetals – right side of the periodic table, including hydrogen and the noble gases (last column)

F. Oxidation States – charges on the most common ions of an element
    1. + is a loss of electrons
    2. – is a gain of electrons
    3. Determining possible oxidation states for an element
        a. Groups 1,2,3 are +1,+2,+3
        b. Groups 12, 13 are +2,+3 (last number in group is the charge)
        c. Nonmetal groups – count backwards from the noble gases (0) Group 17, -1 Group 16, -2 Group 15, -3 Group 14, -4
            1. Positive charges on nonmetals
                1. Even groups – even + charges up to the group number
                2. Odd groups – odd + charges up to the group number (ex. Group 17 is -1, +1, +3, +5, +7)
        d. Transition metals – Groups 4-10
            1. All are +2, +3 and any additional is an even, odd charge (depending on the group up to the group number)
                1. Stops at group 7
                2. Groups 8-10 are +2, +3 only
        e. Transition metals – Group 11 is +1, +2 (except for silver (Ag) which is +1 only