Chapter 1 & 3 Homework: Pages 94 – 97: 31, 33, 35, 36, 38, 41, 42, 43, 46, 50, 52, 54, 58, 61, 64, 67, 69, 72, 75, 76, 77, 82, 85, 89, 91, 93, 98, 99.

I. Chemistry : A Physical Science
    A. The study of matter and the changes it undergoes.
    B. Types
        1. **Analytical Chemistry** - the separation, identification and composition of materials
        2. **Organic Chemistry** - the chemistry of carbon compounds
        3. **Inorganic Chemistry** - chemistry of materials other than those classified as organic
        4. **Physical Chemistry** - the study of the physical characteristics of materials and the mechanisms of their reactions
        5. **Biochemistry** - the study of materials and processes that occur in living things
        6. **Nuclear Chemistry** - the study of subatomic particles and nuclear reactions
        7. **Petroleum Chemistry** - the study of oil, its uses and properties
        8. **Polymer Chemistry** - the study of chains of molecules, i.e. plastics, nylon, polyurethane
        9. **Engineering, Environmental, Chemical Oceanography, Clinical, Forensic**, and the list goes on

II. The Scientific Method
    A. The logical approach to the solution of a problem that lends itself to investigation
    B. Two important questions - “What occurs?”; ”How does it occur?” come from observing a problem
    C. Five General Phases
        1. **Observing** - direct observations, search for information in many places
        2. **Generalizing** - organization of data, looking for relationships
        3. **Hypothesizing** - “educated” guess, based on assumptions and observations, must be testable, from Greek word meaning ground work
        4. **Testing** - objectively test hypothesis using **experiments** (A sequence of observations carried out under controlled conditions)
        5. **Theorizing** - a plausible explanation, based on experimentation, of an observed natural phenomenon in terms of a simple model with familiar properties, predicts future events, from Greek word meaning to look at
    D. **Laws** and **Principles** - generalizations that describe behavior in nature
    E. Simple Scientific Method
        1. Try something, if it works your done, if not, ask why it didn’t work
        2. Try something else until you solve the problem

III. Matter
    A. Anything that takes up space and possesses inertia or has mass
        1. Inertia - resistance to change in position or motion
    B. Mass vs Weight
        1. **Mass** - the quantity of matter that a body possesses, also the measure of inertia of a body
        2. **Weight** - the measure of the earth’s attraction for a body

3. Mass is constant, weight is not

**C. Density**

1. The mass of a unit volume of a material
2. Formula: Density = mass of object/volume of object (grams/mL)

D. Phases of Matter (States) (overhead )

1. **Phase** - uniform part of a system separated from other uniform parts by boundary faces
2. **Solid** - definite shape, definite volume, closely packed, very low entropy
3. **Liquid** - indefinite shape, definite volume, loosely packed, high entropy
4. **Gas** - indefinite shape, indefinite volume, no packing, very high entropy
5. **Plasma** - exists at extremely high temperatures, nuclei are separated from electron clouds, exist in the sun and nuclear explosion
6. **Vapor** - gaseous form of a solid or liquid that is normally a solid or liquid at room temperature (680F or $20^0$C ) (body temp = $37^0$C)
7. **Fluids** - any substance that flows - liquids and gases
8. **Free surfaces** - surface that needs no containment or support
   a. Solids have all free surfaces
   b. Liquids have one free surface
   c. Gases have zero free surfaces

E. Properties of Matter

1. **Specific properties** - properties that are useful in identifying and differentiating matter
2. **Intensive properties** - properties that do NOT depend on the amount of matter present, i.e. - density, melting and boiling points
3. **Extensive properties** - properties that DO depend on the amount of matter present, i.e. - mass, volume, length, weight
4. **Physical properties** - properties that can be determined directly without altering the identity or composition of a material, i.e. - odor, color, texture, solubility, melting, boiling
5. **Chemical properties** - properties that describe the behavior of a material in processes that alter its identity, i.e.-chemical activity: active, inactive, inert
   a. Evidence of a chemical change (reaction)
   (1) evolution of heat and/or light (change in temperature)
   (2) production of a gas
   (3) formation of a precipitate - solid formed from two solutions
   (4) dramatic color change
   (5) new product with new properties

F. Classification of Matter

1. **Heterogeneous** - matter that has parts with different properties, can usually see the different components
2. **Homogeneous** - matter that is the same throughout, cannot see individual components
3. **Mixtures** – materials consisting of two or more kinds of matter each retaining its own characteristics; can be separated physically

a. **Heterogeneous** - mixtures of homogeneous matter, does not have a set of unique properties
b. **Homogeneous** - each component displays its own unique properties but together the mixture has similar properties, called a **solution**, metal solutions are called alloys
c. Separation techniques
(1) **Filtration** – mixture poured through filter paper, larger particles stay in filter
(2) **Distillation** – solution is heated, different substances have different boiling points and will thus boil at different temperatures, vapor is captured and condensed.
(3) **Crystallization** / **Evaporation** – used with solid dissolved in liquid, evaporate liquid (condense and capture if needed), as solute becomes more saturated it will begin to crystallize.
(4) **Sublimation** – one solid goes from solid to vapor stage skipping liquid phase.
(5) **Chromatography** – use the components ability to travel through a stationary phase. Different sized components travel different distances, smaller travels farther.

4. **Substances**
a. Homogeneous material consisting of one particular kind of matter
b. Has definite chemical composition
(1) sugar has properties that stem from itself directly relating to its particular composition
(2) granite, a heterogeneous mixture, has properties that stem from quartz, feldspar and mica

5. **Compounds**
a. Consist of two or more substances chemically combined each component loses its unique properties and forms new unique properties
b. Can be decomposed into two or more simpler substances by ordinary chemical means
(1) Heating
(2) Electrolysis – using electricity to separate
c. **Law of Definite Proportions / Composition** - 1st observed by Louis Proust
(1) Each compound has a definite composition by mass; same elements in same proportions always. Like a recipe.
(2) Can be expresses as a percent by mass which is the

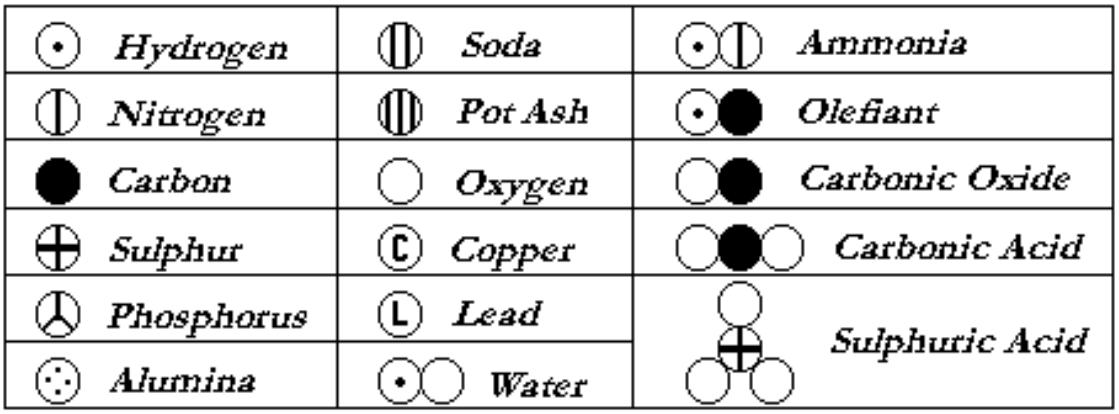
$$\frac{\text{mass of element}}{\text{mass of compound}} \times 100 = \%\ \text{mass}$$

d. **Law of Multiple Proportions** – when different compounds are made of the same elements, different masses of one element combine with the same relative mass of the other element in a ratio of small whole numbers.

6. **Elements**

a. Substances that cannot be decomposed by ordinary chemical means
b. The known elements 118 and growing
   (1) **natural**
      (a) 90 elements from hydrogen to uranium
      (b) two exceptions #43 - Technetium & #61 - Promethium
   (2) **transuranium**
      (a) those beyond uranium
      (b) artificial/man-made elements prepared from other elements during nuclear synthesis
   (3) classes of elements
      (a) **metals** - left hand side of zigzag line
         i) metallic luster - shiny
         ii) good reflectors of heat and light, good conductors of heat and electricity
         iii) ductile - drawn into fine wire
         iv) malleable- hammered, rolled into thin sheets
         v) tenacious - resist being stretched and pulled apart, possess tensile strength
         vi) examples - gold, silver, mercury
      (b) **nonmetals** - right hand side of zigzag line
         i) poor conductors of heat and electricity
         ii) brittle and neither ductile nor malleable
      (c) **noble gases**
         i) nonmetallic
         ii) essentially without chemical reactivity - inert
         iii) group 18 elements
      (d) **metalloids** - border zigzag line
         i) better conductors of electricity than nonmetals but not as good as metals
         ii) also called semiconductors
         iii) silicon, germanium
   (4) chemical symbols - symbols of the elements
      (a) John **Dalton** in 1808 developed circular symbols

***Daltons 1808AD symbols and formulae.***



(b) J. J. Berzellius
  i) Began using first letter of element as symbol, always uppercase printed letter
  ii) Then as letters were repeated, used a second letter that sounded close to the element's name. Ca - calcium, Co - cobalt. This letter is always a printed lowercase letter.
  iii) The letter also represents one atom of the element
(c) Elements you should know - 1-36, 38, 47, 48, 50, 51, 53, 54, 56, 74, 78, 79, 80, 82, 83, 86, 92, 93, 94, 99.
(d) Earth's elemental composition
  i) 90 elements known in either free or combined state in the Earth's crust
  ii) Crust - mostly $O_2$ and Si
  iii) Water - Mostly $H_2$ and $O_2$
  iv) Atmosphere - mostly $N_2$ and $O_2$

IV. The changes that matter undergoes

A. **Physical**
1. Those in which certain physical properties of substances change and their identifying properties remain unchanged
2. Properties that can be observed without altering the identity of the substance
3. Ice == Water == Steam; texture, color, odor

B. **Chemical**
1. Those in which different substances with new properties are formed
2. Properties, that when observed, alter the identity of the substance
3. Activity, Inactivity, Inertness
4. Burning wood, iron rusting, silver tarnishing
5. Any process that absorbs energy as it proceeds is endothermic (endo meaning enter or into; therm referring to heat)
   a. Can be chemical or physical
   b. The products have more energy than the reactants
   c. Photosynthesis (chem); ice melting (phys)
6. Any process that releases energy as it proceeds is exothermic (exo = out)
   a. Can be chemical or physical
   b. The products have less energy that reactants
   c. Burning wood (chem); steam condensing (phys)
   d. This the majority of the chemical reactions
7. Agents used to initiate chemical reactions (chemical initiators)
   a. Heat - each $10^0$ C increase approximately doubles the rate of many reactions. Need to know exo or endo
   b. Light - photosynthesis, photography
   c. Electrical energy - used to decompose $H_2O$ into $H_2$ and $O_2$ ; called electrolysis
   d. Solution in water - allows free exchange of ions, water is the medium in which the reaction can occur – electrolytes conduct electricity; non-electrolytes do not. Salt water vs. sugar water.

e. Catalyst - a substance or combination of substances that increases the rate of a chemical reaction without itself being permanently changed. It accomplishes this by lowering activation energy

8. Reaction tendencies
   a. There is a tendency for processes in nature to occur that lead to a lower energy state and a state of entropy (state of disorder)
   b. Energy needed to start a chemical reaction is called activation energy.
   c. To increase reactions –
      i. Change in energy
      ii. Increase surface area
      iii. Stirring

C. Nuclear changes
   1. The new substances are formed by altering the identity of the atoms themselves not a rearrangement of elemental combinations
   2. Some are spontaneous uranium ==> lead

V. Concept of energy
   A. The capacity/ability to do work; the capacity/ability to change matter
   B. Types of energy
      1. Mechanical
         a. Potential - energy of position, stored energy
         b. Kinetic - energy of motion measured in joules (kg $m^2/s^2$)
            (1) $E_k = ½ mv^2$
      2. Thermal (Heat) - energy that is transferred between two systems
      3. Electrical
      4. Chemical - kind of stored energy, from chem rxns
      5. Radiant - energy from one source emitting in all directions
         a. Radio waves, x-rays, visible light, solar
      6. Nuclear - energy from the atom
   C. Energy can be transformed (changed) from one type to another
      1. Potential E to kinetic E - falling water to electrical at hydroelectric plant
      2. Coal burned - heat released transferred to water, water to steam, steam drives a turbine, turbine drives generator to form electricity
      3. Only the energy change during transformation is measured
   D. Conservation of matter and energy
      1. Matter and energy are interchangeable, and the total matter and energy in the universe is constant, matter and energy can neither be created nor destroyed
      2. In ordinary chemical reactions, the total mass of the reactants is equal to the total mass of the products
      3. Einstein's view
         a. "Matter and energy may represent two different forms of a single, more fundamental, physical quantity."
         b. $E = mc^2$ where E = energy, m = mass, c = speed of light ($3.0 \times 10^8$ m/s)
         c. So with a very small amount of matter enormous amounts of energy can be gained - support - nuclear power