The Periodic Table

I. Periodic Table
- A. Periodic Law - the chemical properties of elements are a periodic (recurring) function of their atomic numbers
  1. Mendeleev's Periodic Table (1869)- developed the table showing the relationship of elements properties and atomic masses
     a. arranged elements by properties and left spaces where he felt an undiscovered element should be (proven correct)
  2. Moseley (1911)- Periodic Table based on Atomic Number - number of protons or electrons
- B. Three types of element - Metals, Metalloids, Nonmetals
  1. Metals - low electronegativity, low ionization energy
     a. form positive ions
     b. high thermal (heat) and electrical conductivity, luster, malleable, ductile
     c. Hg (mercury) - only metal liquid at room temperature
  2. Metalloids (Semimetals)
     a. used as semiconductors (B, Si, As, Te, Ge, At)
     b. mix of properties of metals and nonmetals
  3. Nonmetals - high electronegativity, high ionization energies
     a. form negative ions
     b. tend to be gases, molecular solids or network solids
     c. tend to be brittle, low thermal and electrical conductivity, dull
- C. Reading the Table
  1. Period - each horizontal row of elements
     a. New period - represents the filling of a new principle energy level of electrons
  2. **Group** or Family - each vertical column of elements
     a. electron structures are similar (valence electrons are the same (A groups only))
     b. has one more occupied energy level as you go down
     c. **similar chemical properties**
  3. Transition Elements - B Groups
     a. causes multiple oxidation states (has d subshell electrons)
     b. **ions usually appear colored in solid compounds and solutions**
  4. Naming New Elements - derived from the atomic number
     a. 0 = nil, 1 = un, 2 = bi, 3 = tri, 4 = quad, 5 = pent, 6 = hex, 7 = sept, 8 = oct, 9 = enn
     b. Roots are combined in the order of the atomic number with ium on the end
        1. ex. 105 = un nil pent ium
     c. Symbol - made up of the letters of the roots
        1. ex. 105 = Unp
- D. Group Characteristics
  1. Group 1 Metals - Alkali Metals - form strongest bases
  2. Group 2 Metals - Alkaline Earth Metals
  3. Groups 14, 15, 16 - contain Metals , Metalloids and Nonmetals
  4. Group 17 - Halogens -
     a. exhibits all three phases of matter at room temperature

1. (F_2, Cl_2, gases), (Br_2 - liquid), (I_2 - solid)

5. Group O nonmetals - Rare Gasses or Noble Gases or Inert Gases
   a. very unreactive (stable)

I. Properties of Elements in the Periodic Table

A. **Atomic Radius** – Table S in reference Tables (Regents)
   1. Across Period - atomic radius decreases (electrons pulled in)
   2. Down Group - atomic radius increases (adding new shell)

B. Ion Radius measured in angstroms (Å = 1 X 10^{-10} meters)
   1. Metals - **smaller than atomic radii (lose electrons)**
   2. Nonmetals - **larger than atomic radii (gain electrons)**

C. **Electronegativity** – (Electron Affinity) Table S in reference Tables (Regents)
   1. ability of an element to attract an electron from another element
   2. Across Period - electronegativity increases
   3. Down Group - electronegativity decreases

D. **Ionization Energy** - Table S in reference Tables (Regents)
   1. amount of energy required to remove a valence electron
   2. Across Period - ionization energy increases
   3. Down Group - ionization energy decreases

E. Metallic Properties
   1. Across Period - less metallic
   2. Down Group - more metallic

F. Most Reactivity
   1. Metals - lower left (except Lithium)
      a. lose electrons - form positive ions
   2. Nonmetals - upper right (except Noble Gases)
      a. gain electrons - form negative ions

G. Covalent Radius - one half the distance between nuclei for two atoms covalently bonded together or metallic atoms in a metal

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Honors

III. ***Descriptive Chemistry - describes the sources, properties, and uses of specific elements and their compounds.***

A. ***Alkali Metals - Group IA (means "ashes") many compounds came from wood ashes***
   1. ***Hydroxides (OH) formed are strong bases (ex. NaOH)***
   2. ***Properties - malleable, ductile, lustrous, conduct heat & electricity***
      a. ***low melting point***
      b. ***soft - can cut with a knife***
      c. ***high reactivity - not found free in nature***
         1. ***ex. Na reacts violently in water to produce NaOH (lye)& H_2***
         2. ***must be packed in kerosene***
      d. ***Metals produced by electrolysis***
   3. ***Uses***
      a. ***sodium vapor lamps, preparation of titanium, baking soda ($NaHCO_3$)***

b. ***sodium, potassium alloy used as coolant in nuclear reactors***
c. ***used in photocells & automatic door openers***
1. ***due to ease which they lose electrons***

B. ***Alkaline Earth Metals (Group IIA) - "Earth" refers to the oxides of the metals***
1. ***hydroxides also form strong bases***
2. ***Properties***
a. ***not found free in nature***
1. ***ex. $CaCO_3$ (limestone), CaO (lime)***
b. ***Mg is "self protective" - forms a thin coat of MgO***
3. ***Uses***
a. ***Ba - paint pigments & X-ray diagnosis***
b. ***Mg - dyes, laxatives, rubber production, paints***
c. ***Ca - plaster, building material, drying agent, alkalizing soil***

C. ***Transition Metals - Groups 3-11***
1. ***Properties***
a. ***harder, more brittle than Group I & II metals***
b. ***multiple oxidation states***
c. ***have colored ions***
2. ***Uses***
a. ***Ag - mirrors, coins, tableware, jewelry (best heat & electrical conductor), photography***
b. ***Cu - electrical wiring (#2 conductor), resists corrosion, pipes, roofs***
c. ***Fe - rusts & not self protective, used to make steel***

D. ***Hydrogen***
1. ***Properties***
a. ***nonmetal, highly reactive (1 valence electron), colorless, odorless, tasteless***
b. ***not found free in nature, components of water, acids,fuels***
2. ***Uses***
a. ***production of ammonia***

E. ***Aluminum***
1. ***Properties***
a. ***most abundant metal, not found free in nature (bauxite Al_2O_3)***
2. ***Uses***
a. ***truck bodies, airplanes, cooking utensils***

F. ***Nitrogen Family***
1. ***Properties***
a. ***fairly inactive (forms three covalent bonds (triple bond)***
b. ***compounds of N tend to decompose violently (due to energy required to form them)***
2. ***Uses***
a. ***dyes, celluloid film, lacquer, explosives, ammonia***

G. ***Oxygen***
1. ***Properties***
a. ***highly reactve, component of most rocks, most abundant element, colorless, odorless***
b. ***supports combustion***
c. ***exists as allotropes O_2 & O_3 (blue gas)***

2. ***Uses***
    a. ***Lox fuel for rockets, manufacture of steel***

H. ***Sulfur***

1. ***Properties***
    a. ***has 3 allotropic forms…rhombic, monoclinic (rodlike), noncrystalline all form S_8***
2. ***Uses***
    a. ***vulcanize rubber (hardening), gunpowder, fireworks, matches, medicine***

I. ***Halogens (Greek - salt former)***

1. ***Properties***
    a. ***exist as diatomic molecules, most reactive nonmetals,***
    b. ***not free in nature, abundant***
2. ***Uses***
    a. ***form halides (with hydrogen or metals)***
    b. ***salts, bleach, disinfectants, plastics (pvc), teflon), photographic film, purification***

J. ***Noble Gases (Inert or Rare) - Group 18***

1. ***Properties***
    a. ***He & Ar are common***
    b. ***extremely inactive***
2. ***Uses***
    a. ***weather balloons, airships, artificial atmospheres for divers***
    b. ***light bulbs and signs***