THE PERIODIC TABLE

I. Introduction to the Periodic Table
  A. Development of the periodic table:
    1. Dimitri I. Mendeleev, Russian chemist, (1834 -1907).
      a. in 1869, arranged known elements in order of increasing atomic mass; realized that elements with similar properties fell into groups.
      b. left gaps in the table and predicted properties for three undiscovered elements.
    2. Henry G. J. Moseley, English physicist, (1888 - 1915).
      a. in 1913, arranged elements based on increasing atomic number (number of protons).
      b. missing atomic numbers indicated undiscovered elements.
  B. Today's Periodic Table: elements arranged by increasing atomic number.
    1. periods – 7 horizontal rows in the periodic table whose properties change gradually and predictably.
    2. groups or families- 18 vertical columns of elements in the periodic table.
      a. elements in each group have similar physical or chemical properties.
        1). similar chemical properties result from outer energy levels having the same number of electrons.
    3. zones on the periodic table
      a. representative elements - left and right sides of the periodic table
        1). elements in Groups 1-2 and Groups 13-18
        2). include metals, metalloids, and non-metals
      b. transition elements - center of the periodic table
        1). elements in Groups 3-12
        2). all are metals
      c. inner transition elements - below the main periodic table
        1). elements 58 - 71 *Lanthanide Series* because they follow lanthanum, element 57.
        2). elements 90 - 103, called the *Actinide Series* because they follow actinium, element 89.
  C. Stair-step line - divides the periodic table into:
    1. metals:
      a. 88 elements located to the left of the stair-step line.
      b. more metallic metals on the extreme left

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c. usually have the following physical properties:
   1). have luster – is shiny;
   2). good conductors of heat;
   3). good conductors of electricity;
   4). malleable - can be pressed, pounded, or shaped;
   5). ductile - can be drawn into a thin wire;
   6). solids at room temperature (Hg, mercury, is a liquid).

2. nonmetals
   a. 17 elements, of which all but one located to the right of the stair-step line.
   b. usually have the following physical properties:
      1). dull
      2). poor conductors of heat.
      3). poor conductors of electricity.
      4). are gases or brittle solids at room temperature (Br, Bromine's a liquid).
3. metalloids
   a. 8 elements located next to the stair-step line
   b. have properties of both metals and nonmetals.

D. Element Key - identifies information given on the periodic table
   1. element name
   2. atomic number (number of protons)
   3. symbol
   4. atomic mass
   5. state of matter
   6. synthetic
   7. metal, metalloid, or nonmetal

E. Chemical Symbols - a shorthand or abbreviated way to write an element.
   1. consists of one capital letter or a capital letter plus one or two lower case letters based on:
      a. the element's name;
      b. the first letter of the element's name plus another letter from its name;
      c. the elements Greek or Latin name;

F. Element Names
   1. can be based on a variety of things:
      a. the discoverer's name; a famous scientist; a mythological figure
      b. the name of a place: a planet, the place of discovery;
      c. the Latin name for the atomic number.

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II. Representative Elements – Groups 1 - 2 and Groups 13 – 18.

A. Group 1- Alkali Metals – most reactive metals
   1. in nature always combined with other elements.
   2. active metals that readily combine with other elements
   3. silvery solids w/low densities and low melting points.
   4. Ex.: lithium, Li, in batteries; sodium, Na, in table salt; sodium, Na, and potassium, K, in potatoes and bananas.

B. Group 2- Alkaline Earth Metals
   1. in nature always combined with other elements.
   2. active metals but not as active as alkali metals
   3. denser and harder w/higher melting points than alkalis in the same period.
   4. Ex.: beryllium, Be, in emerald and aquamarine gems; magnesium, Mg, in plant chlorophyll.

C. Group 13 - Boron Family
   1. contains boron, B, a metalloid and four metals
   2. Ex.: boron, B, - a brittle, black metalloid, is used in refrigerator to oven cookware; aluminum, Al, - metal used in soft drink cans, home siding, and baseball bats; gallium, Ga, - metal w/low melting pt. (melts in your hand) that is used in computer chips.

D. Group 14 - Carbon Group
   1. contains a nonmetal, two metalloids and two metals.
   2. carbon, C, a nonmetal, is found in all living things, also exists as graphite, used in pencil lead, and diamonds.
   3. silicon, Si, a metalloid, is found in sand, silicon dioxide, SiO_2, which is used to make glass; silicon is also used in computer chips.
   4. silicon, Si, and germanium, Ge, another metalloid, are used as semiconductors in electronics.
   5. tin, Sn, a metal, is used in pewter, toothpaste, and coating steel cans.
   6. lead, Pb, a metal, is used in lead aprons to shield against unwanted x-rays, car batteries, low-melting alloys, in nuclear reactor shields, particle accelerators, x-ray equipment, and in containers used to store and transport radioactive materials.

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E. Group 15 - Nitrogen Group
   1. contains two nonmetals, two metalloids and a metal.
   2. nitrogen, N, a nonmetal required by living things, makes up almost 80% of the air we breathe, but can't be used by the body in this form;
   3. nitrogen, N, is taken into the body by eating plants that contain nitrogen-fixing bacteria.
   4. phosphorus, P, a nonmetal important in animals for healthy teeth and bones; important for plants; found in plant fertilizers.

F. Group 16 - Oxygen Family
   1. contains three nonmetals and two metalloids.
   2. oxygen, O, makes up about 20% of the Earth's atmosphere; is found in rock and mineral compounds; required for combustion (burning); in the form of ozone shields living organisms from radiation;
   3. sulfur, S, solid yellow nonmetal; sulfuric acid is used in paints, fertilizers, detergents, synthetic fibers, and rubber.
   4. selenium, Se, when exposed to light conducts electricity; used in solar cells, light meters, photographic materials, photocopying machines; traces are needed for good health.

G. Group 17 – Halogens - most reactive nonmetals
   1. contains 4 nonmetals and one radioactive metalloid.
   2. halogen means "salt former"; halogens form salts with the alkali metals; ex. table salt, sodium chloride, NaCl;
   3. fluorine, F, is the most reactive halogen, halogen levels of reactivity decrease as period numbers increase.
   4. chlorine, Cl, added to drinking water to kill bacteria.
   5. iodine, I, added to table salt, iodine is important to many systems of the body.
   6. found as diatomic compounds in nature, bound to a like element, Ex: Cl_2, F_2.

H. Group 18 - Noble Gases – almost completely nonreactive gases
   1. found only as uncombined elements in nature; used in "neon" light: He glows yellow, Ne red orange, Ar blue violet;
   2. helium, He, is less dense than air and inflammable, used in balloons and blimps.
   3. argon, Ar, is the most abundant noble gas on Earth;

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4. krypton, Kr, used w/nitrogen in lightbulbs to keep the filaments from burning out; used in airport landing lights;
5. xenon, Xe, used in strobe lights; once used in photographic flash cubes;
6. a mixture of Ar, Kr, and Xe in lightbulbs makes them last longer.
7. radon, Ra, radioactive gas, produced as uranium decays; can cause lung cancer.

III. Transition Elements: Groups 3-12

A. Groups 3-12 – all transition elements are metals

1. most are found combined with other elements in ores; a few are found as pure elements. Ex. gold, Au, and silver, Ag.
2. properties change less across each period than representative elements.
3. most transition elements have higher melting pts. than representative elements.
4. Iron Triad – iron, Fe, cobalt, Co, and nickel, Ni I (iron), C (cobalt), Nickel
   a. located in period 4.
   b. is magnetic; industrial magnets contain Ni, Co, and Al.
   c. Ni, along with cadmium, Cd, another transition element is used in batteries.
   d. Fe is one of the metals in steel and is in the hemoglobin of red blood cells.

B. Uses of transition elements, elements in groups 3-12

1. tungsten, W, is used for lightbulb filaments because of its high melting pt.
2. mercury, Hg; liquid at room temperature; is poisonous, was once extensively used in barometers and in thermometers because of its low melting/freezing point.
3. chromium, Cr, *(chroma* – Gr. color) used in making chrome objects; forms many colorful compounds: lead chromate, $PbCrO_4$, is used as a in yellow pigment in paints, chromic oxide, Cr_2O_3, produces an emerald green color; gives rubies and emeralds their color.
4. platinum group – ruthenium, Ru, rhodium, Rh, palladium, Pd, iridium, Ir, and platinum, Pt; do not combine readily with other elements.
5. transition elements that can be used as catalysts - substances that speed up reactions but are not consumed in the reaction: the platinum group; nickel; zinc; and cobalt.

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IV. Inner Transition Elements – Lanthanide and Actinide Series

A. Lanthanide Series – elements 58 – 71– naturally occurring elements

1. soft metals, usually found combined with oxygen in the Earth's crust, but may be combined with other lanthanides in ores and difficult to separate.
2. sometimes called the rare earth elements because they were once thought to be rare.
3. cerium, Ce, is used in the misch metals flint, which also contains another lanthanide neodymium, Nd, and two transition elements, lanthanum, La, and iron, Fe.

B. Actinide Series – elements 90 -103

1. radioactive elements, elements that are unstable and decay to form other elements.
2. only 3 actinides are naturally occurring: thorium, Th, protactinium, Pa, and uranium, U; uranium has a long half-life, 4.5 billion years.
3. all other actinides are synthetic elements produced in laboratories and nuclear reactors.
   a. plutonium, Pu, used as fuel in nuclear power plants.
   b. americium, Am, used in smoke detectors.
   c. californium-252, Cm-252, is used to kill cancer cells.