The Periodic Table

- How is it set-up?
- **Introduction to the Periodic Table 3.1**
- http://www.youtube.com/watch?v=TIxiDESxc0I&feature=relmfu
- **Chemistry Periodic Table Layout 3.2**
- http://www.youtube.com/watch?v=PIFPLjGOaH8
- **Periodic Table Trends 3.3**
- http://www.youtube.com/watch?v=HmvpXdxAZrc&feature=channel
- **Periodic Table Basics - ptable.com**
- http://www.youtube.com/watch?v=uQ7g_yz0s1E&feature=related

Groups - Columns - Families (vertical)

1. 1-18 or Roman numerals or A, B

2. Groups have elements with similar chemical and physical properties.

3. All elements in the same group have the same number of electrons in their outer shell.

4. Elements in the same group are like a family because each is different but related through common characteristics.

Periods - Rows

1. Each of the table's horizontal rows is called a **period**.

2. Along a period, a gradual change in chemical properties occurs from one element to another.

3. For example, metallic properties decrease and nonmetallic properties increase as you go from left to right across a period.

4. Changes in the properties occur because the number of protons and electrons increases from left to right across a period or row.
5. The increase in number of electrons is important because the outer electrons determine the element's chemical properties.

6. The periodic table consists of seven periods. The periods vary in length. The first period is very short and contains only two elements, hydrogen and helium. The next two periods contain eight elements each. Periods four and five each have 18 elements. The sixth period has 32 elements. The last period is not complete yet because new exotic or man-made elements are still being made in laboratories.

Alkali Metals

- **Location on the Periodic Table**

The alkali metals are the elements located in Group IA of the periodic table. The alkali metals are lithium, sodium, potassium, rubidium, cesium, and francium.

Alkali Metal Properties

The alkali metals exhibit many of the physical properties common to metals, although their densities are lower than those of other metals. Alkali metals have one electron in their outer shell, which is loosely bound. This gives them the largest atomic radii of the elements in their respective periods. Their low ionization energies result in their metallic properties and high reactivities. An alkali metal can easily lose its valence electron to form the cation. Alkali metals have low electronegativities. They react readily with nonmetals, particularly halogens.

Summary of Common Properties

- Lower densities than other metals
- One loosely bound valence electron
- Largest atomic radii in their periods

Sodium is one of the alkali metals.

Alkaline Earth Metals

- **Location on the Periodic Table**

The alkaline earth metals are the elements located in Group IIA of the periodic table.

Properties

The alkaline earth metals (alkaline earths) possess many of the characteristic properties of metals. Alkaline earths have low electron affinities and low electronegativities. As with the alkali metals, the properties depend on the ease with which electrons are lost. The alkaline earths have two electrons in the outer shell. They have smaller atomic radii than the alkali metals. The two valence electrons are not tightly bound to the nucleus, so the alkaline earths readily lose the electrons to form divalent cations.

Summary of Common Properties

- Two electrons in the outer shell
- Low electron affinities
- Low electronegativities
- Readily form divalent cations.

Magnesium is one of the alkaline earth metals.

Metals

- **Examples of Metals**

Most of the elements on the periodic table are metals, including gold, silver, platinum, mercury, uranium, aluminum, sodium and calcium. Alloys, such as brass and bronze, also are metals.

Location on the Periodic Table

Metals are located on the left side and the middle of the periodic table. Group IA and Group IIA (the alkali metals) are the most active metals. The transition elements, groups IB to VIIIB, are also considered metals. The basic metals are the element to the right of the transition metals. The bottom two rows of elements beneath the body of the periodic table are the lanthanides and actinides, which are also metals.

Properties

Metals are shiny solids are room temperature (except mercury, which is a shiny liquid element), with characteristic high melting points and densities. Many of the properties of metals, including large atomic radius, low ionization energy, and low electronegativity, are due to the fact that the electrons in the valence shell of a metal atoms can be removed easily. One characteristic of metals is their ability to be deformed without breaking. Malleability is the ability of a metal to be hammered into shapes. Ductility is the ability of a metal to be drawn into wire. Because the valence electrons can move freely, metals are good heat conductors and electrical conductors.

Metals

- **Summary of Common Properties**

- Shiny 'metallic' appearance
- Solids at room temperature (except mercury)
- High melting points
- High densities
- Large atomic radii
- Low ionization energies
- Low electronegativities
- Usually, high deformation
- Malleable
- Ductile
- Thermal conductors
- Electrical conductors

Bismuth is one of the basic metals.

Transition Metals

- **Location on the Periodic Table**

The transition elements are located in groups IB to VIIIB of the periodic table.

Properties

The 38 elements in groups 3 through 12 of the periodic table are called "transition metals". As with all metals, the transition elements are both ductile and malleable, and conduct electricity and heat. The interesting thing about transition metals is that their valence electrons, or the electrons they use to combine with other elements, are present in more than one shell. This is the reason why they often exhibit several common oxidation states. There are three noteworthy elements in the transition metals family. These elements are iron, cobalt, and nickel, and they are the only elements known to produce a magnetic field.

Summary of Common Properties

- Low ionization energies
- Positive oxidation states
- Very hard
- High melting points
- High boiling points
- High electrical conductivity
- Malleable

Copper is one of the transition metals.

Nonmetals

- **Location on the Periodic Table**

The nonmetals are located on the upper right side of the periodic table. Nonmetals are separated from metals by a line that cuts diagonally through the region of the periodic table containing elements with partially filled *p* orbitals. Technically the halogens and noble gases are nonmetals, but the nonmetal element group usually is considered to consist of hydrogen, carbon, nitrogen, oxygen, phosphorus, sulfur, and selenium.

Properties

Nonmetals have high ionization energies and electronegativities. They are generally poor conductors of heat and electricity. Solid nonmetals are generally brittle, with little or no metallic luster. Most nonmetals have the ability to gain electrons easily. Nonmetals display a wide range of chemical properties and reactivities.

Summary of Common Properties

- High ionization energies
- High electronegativities

Nitrogen is one of the nonmetals.

Metalloids or Semimetals

- **Location on the Periodic Table**

The metalloids or semimetals are located along the line between the metals and nonmetals in the periodic table. The metalloids are boron, silicon, germanium, arsenic, antimony, and tellurium. Polonium is often considered a metalloid, too.

Properties

The electronegativities and ionization energies of the metalloids are between those of the metals and nonmetals, so the metalloids exhibit characteristics of both classes. Silicon, for example, possesses a metallic luster, yet it is an inefficient conductor and is brittle. The reactivity of the metalloids depends on the element with which they are reacting. For example, boron acts as a nonmetal when reacting with sodium yet as a metal when reacting with fluorine. The boiling points, melting points, and densities of the metalloids vary widely. The intermediate conductivity of metalloids means they tend to make good semiconductors.

Summary of Common Properties

- Electronegativities between those of metals and nonmetals
- Ionization energies between those of metals and nonmetals
- Possess some characteristics of metals/some of nonmetals
- Reactivity depends on properties of other elements in reaction
- Often make good semiconductors

Tellurium is one of the me

Halogens

- **Location on the Periodic Table**

The halogens are located in Group VIIA of the periodic table, and are a particular class of nonmetals. The halogen elements are fluorine, chlorine, bromine, iodine, astatine, and ununseptium.

Properties

These reactive nonmetals have seven valence electrons. As a group, halogens exhibit highly variable physical properties. Halogens range from solid (I2) to liquid (Br2) to gaseous (F2 and Cl2) at room temperature. The chemical properties are more uniform. The halogens have very high electronegativities. Fluorine has the highest electronegativity of all elements. The halogens are particularly reactive with the alkali metals and alkaline earths, forming stable ionic crystals.

Summary of Common Properties

- Very high electronegativities
- Seven valence electrons (one short of a stable octet)
- Highly reactive, especially with alkali metals and alkaline earths

This is a flask of elemental iodine vapor. Iod

Noble Gases

- **Location on the Periodic Table**

The noble gases, also known as the inert gases, are located in Group VIII of the periodic table. Group VIII is sometimes called Group O. The noble gases are helium, neon, argon, krypton, xenon, radon, and ununoctium.

Noble Gas Properties

The noble gases are relatively nonreactive. This is because they have a complete valence shell. They have little tendency to gain or lose electrons. The noble gases have high ionization energies and negligible electronegativities. The noble gases have low boiling points and are all gases at room temperature.

Summary of Common Properties

- Fairly nonreactive
- Complete valence shell
- High ionization energies
- Very low electronegativities
- Low boiling points (all gases at room temperature)

Lanthanides "Rare earths elements or Rare earth metals"

Actinides "Rare earths elements or Rare earth metals"

- The thirty rare earth elements are composed of the lanthanide and actinide series. One element of the lanthanide series and most of the elements in the actinide series are called trans-uranium, which means synthetic or man-made. All of the rare earth metals are found in group 3 of the periodic table, and the 6th and 7th periods. The Rare Earth Elements are made up of two series of elements, the Lanthanide and Actinide Series.

Lanthanides **"Rare earths elements or Rare earth metals"**

- **The D Block Elements**

The lanthanides are located in block 5*d* of the periodic table. The first 5*d* transition element is either lanthanum or lutetium, depending on how you interpret the periodic trends of the elements. Sometimes only the lanthanides, and not the actinides, are classified as rare earths. The lanthanides are not as rare as was once thought; even the scarce rare earths (e.g., europium, lutetium) are more common than the platinum-group metals. Several of the lanthanides form during the fission of uranium and plutonium.

The lanthanides have many scientific and industrial uses. Their compounds are used as catalysts in the production of petroleum and synthetic products. Lanthanides are used in lamps, lasers, magnets, phosphors, motion picture projectors, and X-ray intensifying screens. A pyrophoric mixed rare-earth alloy called Mischmetall (50% Ce, 25% La, 25% other light lanthanides) or misch metal is combined with iron to make flints for cigarette lighters. The addition of <1% Mischmetall or lanthanide silicides improves the strength and workability of low alloy steels.

Lanthanides **"Rare earths elements or Rare earth metals"**

Common Properties of the Lanthanides

Lanthanides share the following common properties:

- Silvery-white metals that tarnish when exposed to air, forming their oxides.
- Relatively soft metals. Hardness increases somewhat with higher atomic number.
- Moving from left to right across the period (increasing atomic number), the radius of each lanthanide 3+ ion steadily *decreases*. This is referred to as 'lanthanide contraction'.
- High melting points and boiling points.
- Very reactive.
- React with water to liberate hydrogen (H_2), slowly in cold/quickly upon heating. Lanthanides commonly bind to water.
- React with H^+ (dilute acid) to release H_2 (rapidly at room temperature).
- React in an exothermic reaction with H_2.
- Burn easily in air.
- They are strong reducing agents.
- Their compounds are generally ionic.
- At elevated temperatures, many rare earths ignite and burn vigorously.
- Most rare earth compounds are strongly paramagnetic.
- Many rare earth compounds fluoresce strongly under ultraviolet light.
- Lanthanide ions tend to be pale colors, resulting from weak, narrow, forbidden *f* x *f* optical transitions.
- The magnetic moments of the lanthanide and iron ions oppose each other.
- The lanthanides react readily with most nonmetals and form binaries on heating with most nonmetals.
- The coordination numbers of lanthanides are high (greater than 6; usually 8 or 9 or as high as 12).

Lanthanides **“Rare earths elements or Rare earth metals”**

Lanthanum is the first element in the lanthanide series.

Actinides **"Rare earths elements or Rare earth metals"**

- **The F Block Elements**

The electronic configurations of the actinides utilize the *f* sublevel. Depending on your interpretation of the periodicity of the elements, the series begins with actinium, thorium, or even lawrencium. The actinides (An) are prepared by reduction of AnF3 or AnF4 with vapors of Li, Mg, Ca, or Ba at 1100 - 1400°C.

Common Properties of the Actinides

Actinides share the following common properties:

- All are radioactive.
- Actinides are highly electropositive.
- The metals tarnish readily in air.
- Actinides are very dense metals with distinctive structures. Numerous allotropes may be formed (plutonium has at least 6 allotropes!).
- They react with boiling water or dilute acid to release hydrogen gas.
- Actinides combine directly with most nonmetals.

Uranium is one of the actinide metals.