Name:____Period:_________
Ms. Randall General Chemistry
Unit 4: Periodic Table

Unit Objectives:

- Describe the origin of the periodic table
- State the modern periodic law
- Explain how an element's electron configuration is related to the element's placement within a period and a group on the periodic table
- Identify and state the properties of the following groups in the periodic table:
    - Alkali metals
    - Alkaline earth metals
    - Halogens
    - Noble Gases
    - Transition elements
- Locate within the periodic table and state the properties of the metals, nonmetals, and metalloids (semi-metals)

<u>Define the following vocabulary:</u>

Nonmetals	Mendeleev	
Ion	Metalloids	Period
Cation	Luster	Group(family)
Anion	Malleability	Alkali Metals
Electron	Ductility	Alkaline Earth Metals
Proton	Conductivity	Halogens
Neutron	Nonmetals	Compound
Brittleness	Element	Dull
Valence electron	Non-conductor	Reactivity
Lewis Dot Diagram	Noble gas	Electron configuration
Metals	Periodic Law	

Lesson 1: **<u>Chemical Periodicity/History of the Table</u>** Date:______________

<u>Objective:</u> To define the development of the Periodic Law

<u>Do Now:</u> **Read below and fill in the Venn diagram**

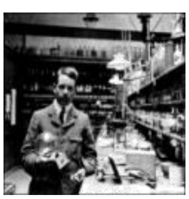
Dmitri Mendeleev (Russia)

Between 1868 and 1870, in the process of writing his book, *The Principles of Chemistry,* Mendeleev created a table or chart that listed the known elements according to increasing order of atomic weights. When he organized the table into horizontal rows, a pattern became apparent--but only if he left blanks in the table. If he did so, elements with similar chemical properties appeared at regular intervals--periodically--in vertical columns on the table.

Mendeleev was bold enough to suggest that new elements not yet discovered would be found to fill the blank places. He even went so far as to predict the properties of the missing elements. Although many scientists greeted Mendeleev's first table with skepticism, its predictive value soon became clear. The discovery of gallium in 1875, of scandium in 1879, and of germanium in 1886 supported the idea underlying Mendeleev's table. Each of the new elements displayed properties that accorded with those Mendeleev had predicted based on his realization that elements in the same column have similar chemical properties. The three new elements were respectively discovered by French, a Scandinavian, and a German scientist, each of whom named the element in honor of his country or region. (Gallia is Latin for France.) Discovery of a new element had become a matter of national pride--the rare kind of science that people could read about in newspapers, and that even politicians would mention.

- 1st chemist to arrange newly found elements into a table form/usable manner
- Elements arranged according to **<u>Atomic mass</u>**
- Resulted in **<u>gaps</u>** or periodic intervals being **<u>out of order</u>**

Periodic = cyclic; repeating patterns/cycles; similar to monthly/weekly calendar (days of the week)
Ex: tired on Mondays, happy on Fridays



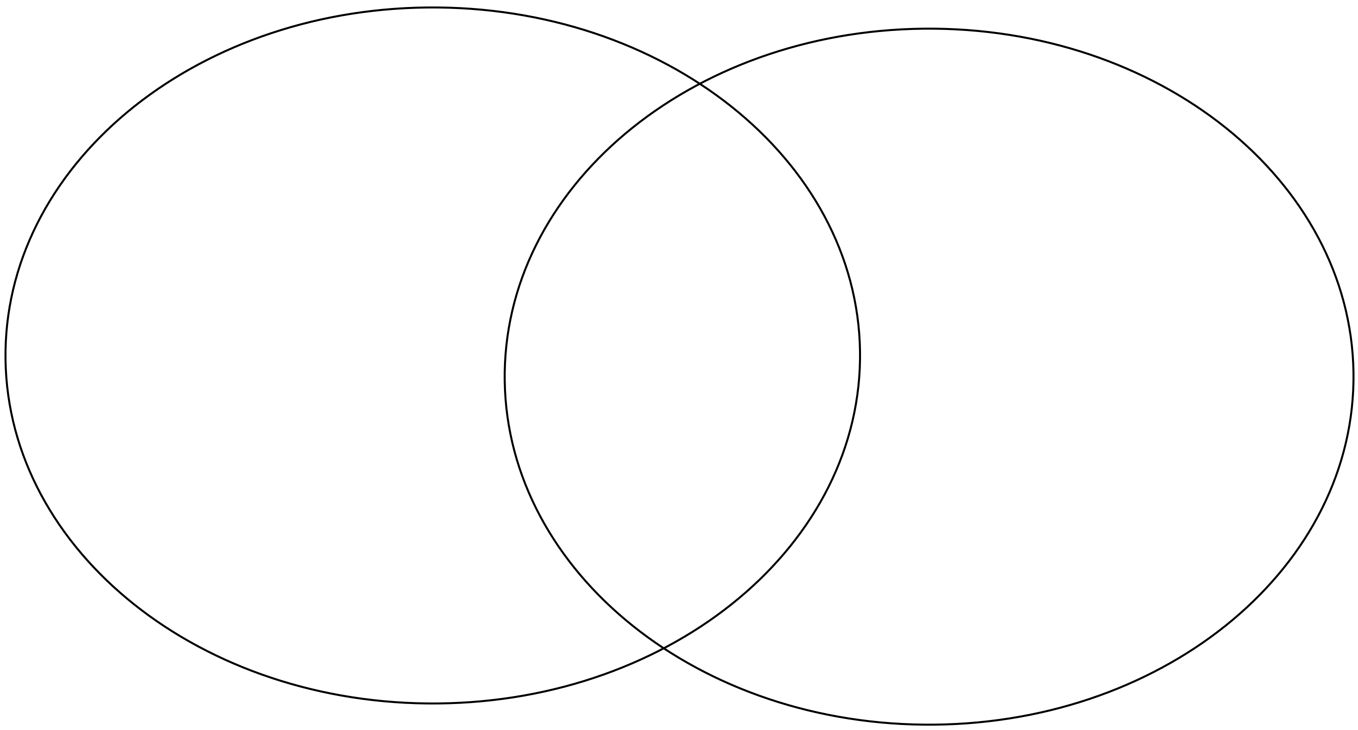
Henry Moseley (England)

By 1907, when Mendeleev died, chemists were sure that iodine followed tellurium in the Periodic Table and that there was something odd about their relative atomic masses. However no-one was able to *measure* atomic number, it was just the position of an element in the Periodic Table sequence. For example lithium was known to be the third element but this number three was only because its properties meant that it slotted in between helium and beryllium. **Henry Moseley** found and measured a property linked to Periodic Table position. Hence atomic number became more meaningful and the three pairs of elements that seemed to be in the wrong order could be explained. Moseley used what was then brand-new technology in his experiments. A device now called an electron gun had just been developed. He used this to fire a stream of electrons (like machine gun bullets) at samples of different elements. He found that the elements gave off X-rays. (This is how the X-rays used in hospitals are produced.) Moseley measured the frequency of the X-rays given off by different elements. Each element gave a different frequency and he found that this frequency was mathematically related to the position of the element in the Periodic Table – he could actually measure atomic number!

- Arranged table by **<u>Atomic number</u>** (or # of protons) which proved to be much more effective
- How the **<u>modern day</u>** periodic table is arranged

Periodic Law = elements in periodic table are **periodic** functions of their **atomic number**

Check your understanding: Compare and contrast Mendeleev's organization of the elements with Moseley's in the Venn diagram provided below.

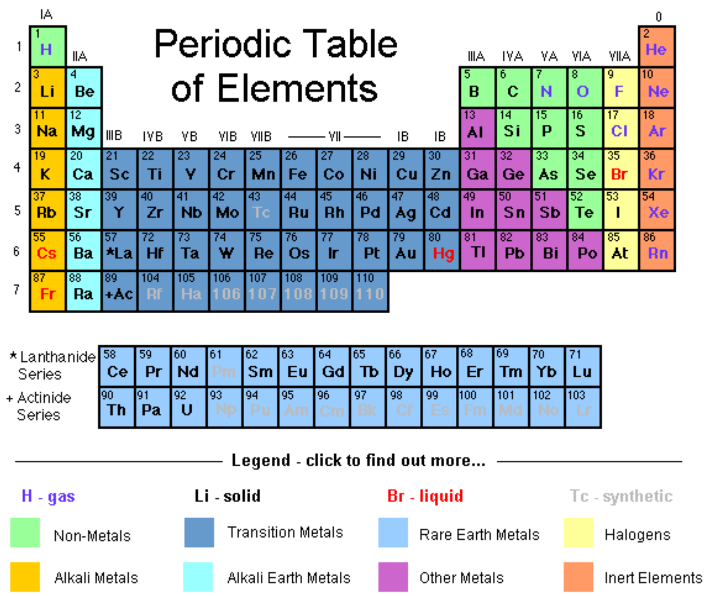


Lesson 2: Arrangement of the Periodic Table ***Date:*** ______

Objective: To observe and define groups and periods in the periodic table of elements

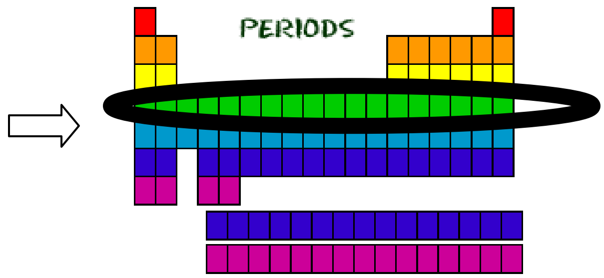
Do Now: The modern periodic table isn't the only way to categorize the elements. What are some other ways you could list and organize the elements?

____
____
____
____
____
____



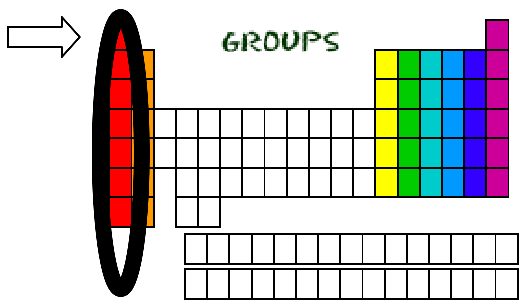
The Periodic Table is made up of **Periods** and **Groups:**

1. **Periods** = **Horizontal rows** (run left to right) on Periodic Table



The period number tells us the number of **electron shells** (principal energy levels)
The properties of elements change drastically across a period from metals → metalloids/semi-metals → nonmetals. The number of **valence electrons** increases from left to right (1 → 8)

2. Groups (Families) = **vertical columns** (run up & down) on Periodic Table; each group contains the same number of **valence electrons and similar** (not identical) chemical/physical properties.



Example: K in Group 1
Let's look at the electron configuration of elements in the same group…

H = **1**
Li = **2-1**
Na = **2-8-1**
K = **2-8-8-1**
Rb = **2-8-18-8-1**
Cs = **2-8-18-18-8-1**
*Fr = **-18-32-18-8-1**

What similarities can you observe within the above electron configurations?

All have **1** valence electron

Remember…

Group # = **number of valence electrons**
Period number = **number of principle energy levels**

Why do elements in the same group have similar chemical/physical properties?

- They have the same **number of valence electrons**
- Valence electrons affect **Reactivity**

Reactive elements can bond *easily w/ other elements. They have an* ***incomplete valence electron shell****.*

- All atoms (except hydrogen and Helium) want **8 electrons** in their valence shell (outermost energy level)

Octet = full **valence shell** (8 electrons, except for period 1 elements….they need 2 to have a full valence shell) ***8 is Great!!!***

*******KNOW THIS!!!!*******

Octet Rule

Atoms tend to gain, lose or share one or more of their valence electrons to achieve a filled outer electron shell

Check your understanding:

1. The rows of the periodic table are called:

a) Classes
b) Periods
c) Groups
d) families

2. The scientist credited with devising the first periodic table similar to the one we use today was:

a) John Dalton
b) Gregor Mendel
c) Dmitri Mendeleev
d) Ernest Rutherford

3. The primary difference between the modern periodic table and Mendeleev's periodic table is:

a) The two tables are the same except we know about more elements now.
b) Mendeleev's table did not arrange the elements according to recurring trends in their properties.
c) The elements in the modern table are arranged in order of increasing atomic weight.
d) The elements in the modern table are arranged in order of increasing atomic number.

Lesson 3: It's Elemental Date:_______

Objective: To summarize the structure and information located in the periodic table

DIRECTIONS: *Use the reading below to answer the questions that follow.*

We all know by now that the periodic table is arranged according to increasing atomic number. What we're only beginning to learn is the significance of elements within the same column (vertical) and row (horizontal) on the table.

Every element found within a given row, or ***period***, has the same number of electron shells, or ***principle energy levels***. Despite this one common feature, atoms of one element within a given period do not behave similar to atoms of another element in that same period. In fact, the period in which an element is found really tells you nothing about how the atoms of that element will behave. The only additional thing that we can really say about elements of the same period is that they increase by very little in terms of size (or mass) as we go from left to right on the table since the atomic number(number of protons) only goes up by one. Look at the periodic tables that you labeled and color-coordinated. Look at how much the mass increases as you move from left to right in a given period.

Every element found within a given column, or ***group***, has the same number of ***valence electrons***. This is VERY significant because it's the number of valence electrons that determines how atoms of any element are going to "behave." When we say "behave," what we really mean is how they're going to ***react***, or ***bond*** with atoms of other elements. However, not all columns or groups qualify as "families." In fact, the only groups that are considered to be families are Group I (Alkali Metals), Group II (Alkaline Earth Metals), Group XVII (Halogens), and Group XVIII (Noble Gases). The behaviors of the transition metals are very difficult to predict, and the behavior of the elements within the BCNO group varies greatly from one element to another. *An element's family tells you much more about its properties than its period does*.

All of the elements in the Halogen family have 7 valence electrons. There's an easy way to cheat when it comes to determining the number of valence electrons. Just look at the last digit of the group number above the first element in the family. For the first two families (alkali metals and alkaline earth metals) it's a single digit number, so there's no confusion. Alkali metals are group 1, which means all elements in that family have 1 valence electron. The halogen family, on the other hand, is group 17, which means they have how many electrons in their valence shell? If you said 7, you're right. This trick will help you when it comes to drawing Lewis dot diagrams…

Speaking of the Lewis dot diagram, it's used to show only the ***valence electrons*** in a given atom or compound. After all, the valence electrons are the only electrons involved in ***bonding***. There are four basic spots that an electron can occupy in a Lewis dot diagram because the maximum number of valence electrons that an atom of an element can generally hold is eight. If the element symbol was the face of a clock, the spots would be at 12 o'clock, 3 o'clock, 6 o'clock, and 9 o'clock. The first spot is like a taxi cab that can hold two electrons in its single seat. The remaining three spots are like seats on a bus that can also hold electrons. Just as you would do if you got onto a bus, electrons look for empty seats first. Once the taxi cab is full, the remaining electrons in the valence shell occupy empty "seats." Only after each of the three seats has an electron in it do they begin to pair up. The exceptions to the octet rule are elements that have only one energy level or seek to have one energy level. These elements include hydrogen, helium, lithium, beryllium, and boron. These elements also seek to have a full valence shell, but it will only contain two electrons. Otherwise, there can never be more than 8 valence electrons and, no matter what, there can never be more than 2 electrons in a given "seat."

All atoms seek to have a full valence shell, and the easiest way to do that is to form bonds with other atoms. We mentioned before that atoms in the family of noble gases already have a full valence shell, and that's why they rarely ever seek to bond with other atoms. For all other element families, the atoms seek to form bonds in order to complete their valence shell. As a general rule, the number of ***unpaired*** valence electrons tells you the number of bonds that atoms of a given element "like" to form. Halogens, like chlorine (Cl), have 7 valence electrons and only one unpaired valence electrons. That means that the halogens have two choices: They can either steal an electron, usually from an atom with only 1 valence electron, like sodium (Na), forming what we call an ***ionic bond***. The other choice an atom like chlorine has is to share an electron with an atom that's also one short of having a full valence shell, like another chlorine atom. This ***sharing of electrons*** is an example of a ***covalent bond***. As we said before, carbon has 4 valence electrons, which means that all of them can occupy a seat unpaired for a maximum of 4 unpaired valence electrons. That's why carbon looks to share each of its 4 single valence electrons in order to end up with 4 ***pairs*** instead, giving it the full 8 it needs to fill its valence shell. In other words, carbon will form 4 covalent bonds. A single line is used to illustrate a bond between two atoms, and each single line represents 2 electrons.

1. How is the periodic table arranged?

2. What do we call the horizontal rows of the periodic table? What do all the elements in a given row have in common?

3. What do we call the vertical columns of the periodic table? What do all the elements in a given column have in common?

4. Which tells us more about an element's properties, its row or its column? Why is this?

5. Which of the following elements is chlorine (Cl) most similar to?
   a. fluorine (F)
   b. sulfur (S)
   c. oxygen (O)
   d. argon (Ar)

6. Does mass increase more as we go from left to right or top to bottom on the periodic table?

7. Are atoms of the elements in the family of noble gases reactive (do they readily form bonds with other atoms)? Why is this?

8. How are ionic bonds formed?

9. How are covalent bonds formed?

10. What determines how many bonds an atom will form?

11. What is the easiest way for atoms without a full valence shell to gain a full valence shell?

12. If an atom of an element has four valence electrons, what is the maximum number of unpaired electrons it can have? Draw a Lewis Dot diagram of an element that fits this description.

13. Why do chlorine (Cl) and sodium (Na) bond so easily with one another?

Lesson 4: The Groups **Date:__________**

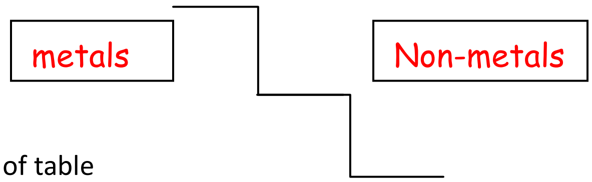
Objective: To define the properties of the various groups in the periodic table

Do Now: An Elemental Tale: The Gold Dust Kid

The Kid mounted his trusty steed, old [B] ___________. His shooting [Fe] ____________ strapped to his side, he headed out for the bright [Ne] ____________ lights of Toronto, aiming to rob the mid-day stage. There was sure to be a load of precious [U] ______________ aboard, and probably [K] ____________, too. Inhaling a deep breath of [O] __________ he coughed on the [S] ____________ from the nearby mills. Since the [Hg] ______________ was climbing, he quenched his thirst with some H_2O, tasting the [Cl] ____________ all big cities like Brockville had. As he headed north his bones ached from [Ca] _____________deposits built
up over the years of riding the [Zn] ____________ trail.
Overhead a [He] __________-filled balloon floated in the breeze; the sun beat down like burning [P] ____________.
Soon he spotted the stage, guarded only by a sheriff with a [Sn] ____________ badge. "Halt," he yelled. "or I'll fill you full of [Pb] ____________." The sheriff drew his gun, but alas, was too slow. The Kid's gun, blazing like flaming [Mg] ______________ did the [Cu] ____________ in. Anyone who drew on the Kid should know his life wasn't worth a plugged [Ni] ______________. A [Pt] ____________ blonde riding beside the [Al] ___________-framed coach rode for her life when the Kid pulled out some [N] ____________ compounds, preparing to blow the safe to atoms.
Suddenly, a shout rang out, "Hi Ho [Ag] ___________ and a masked man on a white horse raced across the [Si] ____________ sands like [Na] ______________ skittering on H_2O. A [H] ___________ bomb would not have stopped the lawman; the Kid had met his doom. The rest of his life was to be spent behind [Co] ___________ steel bars, a warning to all who flirt with danger. Your first detention may be the initial step in a [C] ____________ copy life of the saga of the [Au] ____________ dust Kid. *Author unknown*

The Periodic Table can be "keyed" for many things!

The Staircase

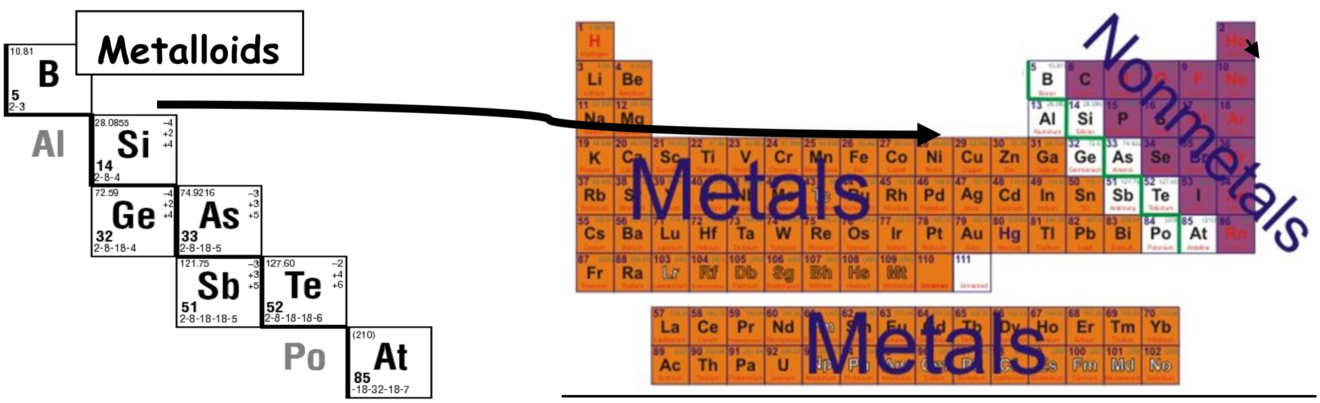


1. **Metals:**
   - make up **MOST** of table
   - **LEFT** of or **BELOW** staircase—except **HYDROGEN**
   - all **SOLIDS** (except **Hg**)
   - **MALLEABLE** (can be hammered/molded into sheets)
   - **DUCTILE** (can be drawn/pulled into wire)
   - Have **LUSTER** (are shiny when polished)
   - Good **CONDUCTORS** (allow heat & electricity to flow through them)
     - due to "sea of **MOBILE** valence electrons"
   - Like to **LOSE** e^- to form **POSITIVE** ions….why?

   TO HAVE A FULL VALENCE SHELL OF ELECTRONS

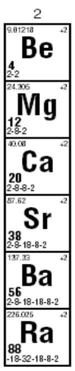
2. **Nonmetals:**
   - **RIGHT** of or **ABOVE** staircase
   - mostly **GASES** and **SOLIDS** @ STP—except **Br(l)**
   - **NOT** malleable/ductile; **BRITTLE** (shatter easily)
   - **LACK** luster (**DULL**)
   - **NON** or **POOR** conductors
   - like to **GAIN** e^- to form **NEGATIVE** ions

3. **Metalloids** (AKA semi-metals):
   - have properties of both **METALS** & **NONMETALS**
   - **ALONG** staircase (between **METALS** & **NONMETALS** on table)—except **Al & Po**



Group 1 → ALKALI METALS (FAMILY)
Watch: http://ttc.wfsd.k12.ny.us/safevideos/Video.aspx?id=ezELLZ7_YAc

- All have 1 valence electron
- Easily LOSE their one electron to become +1 ions
- EXTREMELY reactive → never found alone in nature
- Contains the MOST reactive metal: Probably FRANCIUM (Fr), but it's so rare, we've got to go with CESIUM (Cs)



Group 2 → ALKALINE EARTH METALS (FAMILY)

- All have 2 valence electrons
- Prefer to LOSE their two electrons to become +2 ions
- FAIRLY reactive → never found alone in nature

Groups 3-12 →TRANSITION METALS

- Found in the MIDDLE of the table (the D block)
- Form COLORED IONS in solution (ex: Cu is bright blue when dissolved in water)
- Tend to be UNPREDICTABLE → will lose electrons or gain them depending on what other METALS are present
- LEAST reactive group of metals

Groups 13-16 → BCNO groups (not a single group)

MISCELLANEOUS groups
- Metals, nonmetals, & metalloids found along the staircase (many different properties)

Group 17 → HALOGENS (FAMILIY)

- 7 valence electrons
- Like to gain 1 electron to become ions with -1 charge (8 is great!)
- Form SALTS/COMPOUNDS called HALIDES
- Contains the most (RE)ACTIVE nonmetal: FLUORINE (F)
- All NONMETALS making up the group
- Three states of matter found in group: SOLID (s), LIQUID (l), GAS (g)
  Ex: Chlorine (Cl)

Group 18 → NOBLE GASES (FAMILY)

- UNREACTIVE or INERT
- Have OCTET (8 e- in valence shell/outer energy level)
- Most STABLE group; exist ALONE in nature
- Exception to the OCTET is He (only has 2 valence e-)
- EVERYONE WANTS TO BE A NOBLE GAS & HAVE 8 ELECTRONS! 8 IS GREAT!
  Ex: Neon (Ne)

Hydrogen → Not officially part of a group

- Both a NONMETAL and a GAS
- Can be seen as $H_2(g)$, $H^+(aq)$ or $H^-(aq)$

The Lanthanide/Actinide Series

- Two rows on bottom of table (detached) – Elements 58 – 71 & 90 - 103
- Actually belong to the TRANSITION METALS

Check your understanding:

1. Classify each of the following elements as a **metal, non-metal, metalloid** or **noble gas**. Indicate the number of valence electrons for each.

a. calcium

b. silicon

c. oxygen

d. argon

e. potassium

f. phosphorus

2. What is the noble gas in Period 4 ________________

5. Name the metal in Group 2, Period 6 _______________

6. Metals ___________ valence electrons to form
(lose, gain)

_____________charged_______
(positively, negatively) (cations, anions)

7. Non-metals ___________ valence electrons to form
(lose, gain)

_____________charged_______________.
(positively, negatively) (cations, anions)

Lesson 5: **Periodic Properties**
Objective: To describe the properties of elements based on their location on the periodic table

Do Now:

Directions: Use the word bank below to fill in the blanks in the passage that follows.

Actinide series	Group	Nonmetal
Alkali metal	Halogen	Period
Alkaline earth metal	Lanthanide series	Periodic law
Atomic mass	Metal	Periodic table
Atomic number	Metalloid	Transition element
Family	Noble gas	

Dmitri Mendeleev developed a chart-like arrangement of the elements called the ________________________. He arranged the elements in order of increasing ________________________, but what he discovered were many gaps. The chart was not that organized and easy to use. The arrangement used today differs from that of Mendeleev in that the elements are arranged in order of increasing ______________. He called this the __________________of the elements. Each horizontal row of elements is called a(n) ________________. Each vertical column is called a(n) _________________, or because of the resemblance between elements in the same column, a(n) ____________.

In rows 4 through 7, there is a wide central section containing elements, each of which is called a(n) _____________________. Rows 6 and 7 also contain two other sets of elements that are listed below the main chart. These are called the _______________
and the _________________, respectively. Each of these elements, as well as those in the first two columns at the left end of the chart, is classified as a(n) ______________________. Each of the elements at the right side of the chart is classified as a(n) __________________. Each of the elements between these two main types, having some properties like one type and other properties like the other type, is called a(n) _________________________.

Each of the elements in Group 1 is called a(n) ____________________. Each of the elements in Group 2 is called a(n) ____________________. Each of the elements in Group 17 is called a(n) ____________________. Each of the elements in Group 18 is called a(n) _____________________.

Please read the following passage.

Certain properties of the elements demonstrate **trends** that repeat in a regular pattern every so many elements. In other words the trends are repeated **periodically.** The periodic trends repeat as a function of the periods of elements on the periodic table.

Within a particular group of elements, the atoms of the elements at the top of the group are smaller in size due to having fewer electron energy levels. This means it is harder to remove a valence electron from atoms that are smaller, as these electrons are closer to the nucleus and more attracted to the nucleus.

So the trend of "**metallic character**" can be thought of this way. Metals tend to want to lose valence electrons to become like noble gases. Atoms that give up their valence electrons more easily have more "metallic character" than those that do not. Therefore, no matter what group we look at, the elements at the bottom are more metallic than those at the top. Simply stated, this means they are more likely to lose valence electrons in bonding. Conversely, the elements at the top of a group are more non-metallic, having a tighter hold on valence electrons. Within periods, the most metallic elements are to the left (Group 1), and the most nonmetallic to the right (Group 17). Said another way, the most metallic element is to the lower left (Fr) and the most nonmetallic to the upper right (F).

Electronegativity is a measure of the ability an atom has to attract electrons to it in a bonding situation. If you understood the paragraph above, then it should be no huge leap in logic to understand that metals have low electronegativity values, and that nonmetals have high values. Noble gases of course have electronegativity values of zero. The highest value belongs to the most nonmetallic element – Fluorine – at 4.0, and the lowest value belongs to the most metallic element – Francium – at 0.7.

First Ionization Energy is a measure of the amount of energy needed in order to rip the most loosely held valence electron away from an atom. If you think about it, the noble gases should have the highest values, since they have a stable octet and do not want to lose electrons. Next, the nonmetals have fairly high values, as they would also rather not lose electrons. Metals have low values (in other words, they do not put up much of a fight when we try to take an electron away… after all they are trying to lose electrons anyways). So atoms to the top of groups and to the right in periods have high values, with the lower values being lower in a group and to the left on the Periodic Table.

Check your understanding:

1. Why is the table of elements called the "Periodic" table?

2. Why is it easier to take a valence electron away from an atom that has that electron in the 5^{th} energy level, versus one that has it in the 1^{st} energy level?

3. What is the most metallic element in each of these Groups?

Group 1: ______

Group 2: ______

Group 14: ______

Group 17: ______

Group 18: ______

4. (T/F) _____ If an element is quite "metallic" then that is a way of saying that it will be quite difficult to remove a valence electron from its atoms.

5. Non-metal atoms tend to ____________*(gain or lose?)* valence electrons, so they tend to have ______________ *(high or low?)* electronegativity values.

6. Look up the electronegativity values for the noble gases, on Table S.

What do you discover?

Why is this?

7. If you apply "ionization energy" to an atom, what have you done to it?

8. Why are the ionization values for noble gases so high?

<u>Lab activity:</u> Color Coding the Periodic Table **Date:_________**

<u>Background:</u> The Periodic Table is a list of all the known elements. It is organized by increasing atomic number. There are two main groups on the periodic table: metals and nonmetals. The left side of the table contains elements with the greatest metallic properties. As you move from the left to the right, the elements become less metallic with the far right side of the table consisting of nonmetals. The elements in the middle of the table are called "transition" elements because they are changed from metallic properties to nonmetallic properties. A small group whose members touch the zigzag line are called metalloids because they have both metallic and nonmetallic properties.
The table is also arranged in vertical columns called "groups" or "families" and horizontal rows called "periods." Each arrangement is significant. The elements in each vertical column or group have similar properties. Group 1 elements all have the electron in their outer shells. This gives them similar properties. Group 2 elements all have 2 electrons in their outer shells. This also gives them similar properties. Not all of the groups, however, hold true for this pattern. The elements in the first period or row all have one shell. The elements in period 2 all have 2 shells. The elements in period 3 have 3 shells and so on. In this activity, you will color code the periodic table to show how some elements have the same properities.

There are a number of major groups with similar properties. They are as follows:

Hydrogen: This element does not match the properties of any other group so it stands alone. It is placed above group 1 but it is not part of that group. It is a very reactive, colorless, odorless gas at room temperature. (1 outer level electron)

<u>Group </u>1: Alkali Metals – These metals are extremely reactive and are never found in nature in their pure form. They are silver colored and shiny. Their density is extremely low so that they are soft enough to be cut with a knife. (1 outer level electron)

<u>Group 2: </u>Alkaline-earth Metals – Slightly less reactive than alkali metals. They are silver colored and more dense than alkali metals. (2 outer level electrons)

<u>Groups 3 – 12</u>: Transition Metals – These metals have a moderate range of reactivity and a wide range of properties. In general, they are shiny and good conductors of heat and electricity. They also have higher densities and melting points than groups 1 & 2. (1 or 2 outer level electrons)

<u>Lanthanides and Actinides</u>: These are also transition metals that were taken out and placed at the bottom of the table so the table wouldn't be so wide. The elements in each of these two periods share many properties. The lanthanides are shiny and reactive. The actinides are *all* radioactive and are therefore unstable. Elements 95 through 103 do not exist in nature but have been manufactured in the lab.

<u>Group 13:</u> Boron Group – Contains one metalloid and 4 metals. Reactive. Aluminum is in this group. It is also the most abundant metal in the earth's crust. (3 outer level electrons)

<u>Group 14</u>: Carbon Group – Contains on nonmetal, two metalloids, and two metals. Varied reactivity. (4 outer level electrons)

<u>Group 15</u>: Nitrogen Group – Contains two nonmetals, two metalloids, and one metal. Varied reactivity. (5 outer level electrons)

Group 16: Oxygen Group – Contains three nonmetals, one metalloid, and one metal. Reactive group. (6 outer level electrons)

Groups 17: Halogens – All nonmetals. Very reactive. Poor conductors of heat and electricity. Tend to form salts with metals. Ex. NaCl: sodium chloride also known as "table salt". (7 outer level electrons)

Groups 18: Noble Gases – Unreactive nonmetals. All are colorless, odorless gases at room temperature. All found in earth's atmosphere in small amounts. (8 outer level electrons)

Materials: colored pencils, table

Procedure:

This worksheet will help you understand how the periodic table is arranged. Your teacher will give you a copy of the periodic table to color. Using colored pencils, color each group on the table as follows:

1. Color the square for Hydrogen pink.
2. Lightly color all metals yellow.
3. Place black dots in the squares of all alkali metals.
4. Draw a horizontal line across each box in the group of alkaline earth metals.
5. Draw a diagonal line across each box of all transition metals.
6. Color the metalloids purple.
7. Color the nonmetals orange.
8. Draw small brown circles in each box of the halogens.
9. Draw checkerboard lines through all the boxes of the noble gases.
10. Using a black color, trace the zigzag line that separates the metals from the nonmetals.
11. Color all the lanthanides red.
12. Color all the actinides green.

When you are finished, make a key that indicates which color identifies which group.

Analysis:

Follow the instructions below to label the major groups and divisions of the periodic table.

1. The vertical columns on the periodic table are called ____________.
2. The horizontal rows on the periodic table are called _____________.
3. Most of the elements in the periodic table are classified as _____________.
4. The elements that touch the zigzag line are classified as _______________.
5. The elements in the far upper right corner are classified as______________.
6. Elements in the first group have one outer shell electron and are extremely reactive. They are called ___________ ______________.
7. Elements in the second group have 2 outer shell electrons and are also very reactive. They are called ______________ ______________ ________________.
8. Elements in groups 3 through 12 have many useful properties and are called _________________ _______________.
9. Elements in group 17 are known as "salt formers". They are called _________________.
10. Elements in group 18 are very unreactive. They are said to be "inert". We call these the ______________ ______________.
11. The elements at the bottom of the table were pulled out to keep the table from becoming too long. The first period at the bottom called the _________________.
12. The second period at the bottom of the table is called the _____________________.

Lab activity: Alien Periodic Table **Date:_______**

Background: Imagine that inhabitants of another planet send data about 30 elements to Earth. However, these inhabitants use different names and symbols for these elements than humans do. Which elements on the periodic table do these "alien" names represent?

Objective:

- Draw conclusions about the Earth names of the alien elements based on atomic number.
- Classify elements based on their properties.
- Interpret data on the properties of elements.
- Infer the position of the elements on the periodic table.

Procedure:

1. Be sure to record your data in the blank periodic table on the next page.
2. Listed below are data on the chemical and physical properties of the 30 elements. Place the elements in their proper position in the blank periodic table.
   - The noble gases are bombal (Bo), wobble (Wo), jeptum (J), and logon (L). Among these gases, wobble has the greatest atomic mass and bombal the least. Logon is lighter than jeptum.
   - The most reactive group of metals are xtalt (X), byyou (By), chow (Ch), and quackzil (Q). Of these metals, chow has the lowest atomic mass. Quackzil is in the same period as wobble.
   - Apstrom (A), vulcania (V), and kratt (Kt) are nonmetals whose atoms typically gain or share one electron. Vulcania is in the same period as quackzil and wobble.
   - The metalloids are ernst (E), highho (Hi), terriblum (T), and sississ (Ss). Sississ is the metalloid with the greatest atomic mass. Ernst is the metalloid with the lowest atomic mass. Highho and terriblum are in Group 14. Terriblum has more protons than highho. Yazzer (Yz) touches the zigzag line, but it's a metal, not a metalloid.

   - The lightest element of all is called pfsst (Pf). The heaviest element in the group of 30 elements is eldorado (El). The most chemically active nonmetal is apstrom. Kratt reacts with byyou to form table salt.
   - The element doggone (D) has only 4 protons in its atoms.
   - Floxxit (Fx) is important in the chemistry of life. It forms compounds made of long chains of atoms. Rhaatrap (R) and doadeer (Do) are metals in the fourth period, but rhaatrap is less reactive than doadeer.
   - Magnificon (M), goldy (G), and sississ are all members of Group 15. Goldy has fewer total electrons than magnificon.
   - Urrp (Up), oz (Oz), and nuutye (Nu) all gain 2 electrons when they react. Nuutye is found as a diatomic molecule and has the same properties as a gas found in Earth's atmosphere. Oz has a lower atomic number than urrp.
   - The element anatom (An) has atoms with a total of 49 electrons. Zapper (Z) and pie (Pi) lose two electrons when they react. Zapper is used to make lightweight alloys.

Analyze and Conclude

Write your answers on a separate sheet of paper.

1. **Drawing Conclusions:** List the Earth names for the 30 alien elements in order of atomic number.

2. **Classifying:** Were you able to place some elements within the periodic table with just a single clue? Explain using examples.

3. **Interpreting Data**: Why did you need two or more clues to place other elements? Explain using examples.

4. **Inferring:** Why could you use clues about atomic mass to place elements, even though the table is now based on atomic number?

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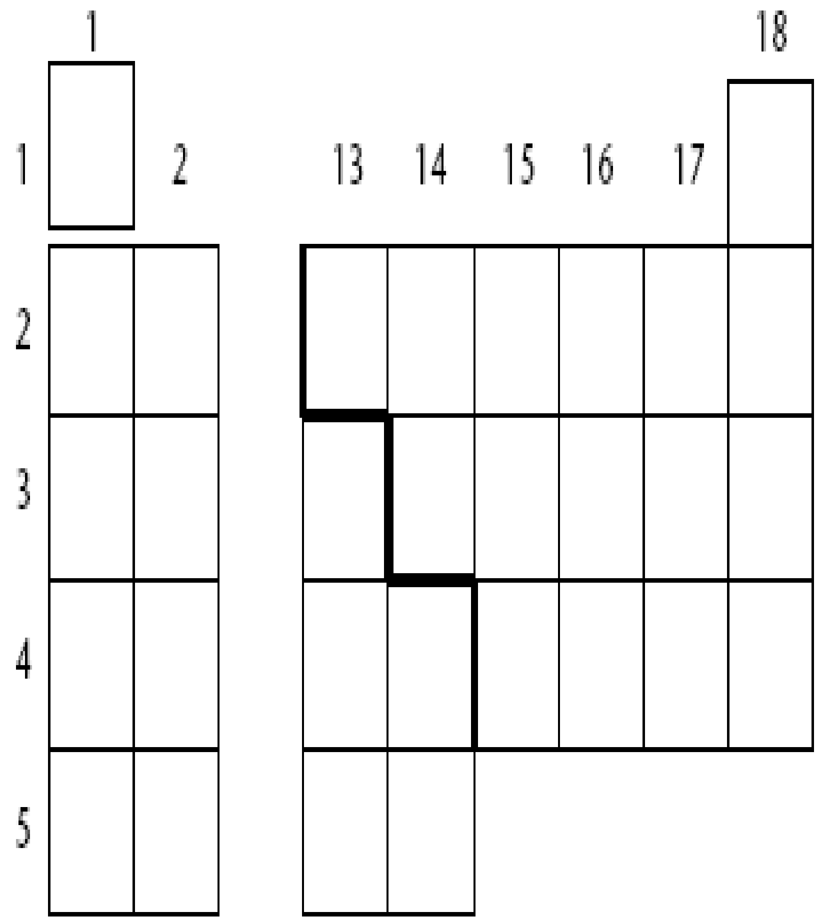
Alien Periodic Table



Lab activity: Show Me the Oxygen

Background: (adapted from http://www.chemicool.com/elements/oxygen.html)

Oxygen is a highly reactive non-metal. It was discovered in 1774 by Joseph Priestley in England and two years earlier, but unpublished, by Carl W. Scheele in Sweden. Scheele heated several compounds including potassium nitrate, manganese oxide, and mercury oxide and found they released a gas which enhanced combustion. Combustion is a chemical reaction that causes a large generation of heat and light.

Priestley heated mercury oxide, focusing sunlight using a 12-inch 'burning lens' – a very large magnifying glass – to bring the oxide to a high temperature. Totally unexpectedly, the hot mercury oxide yielded a gas that made a candle burn five times faster than normal. Priestley wrote: "But what surprised me more than I can well express was that a candle burned in this air with a remarkably vigorous flame. I was utterly at a loss how to account for it." In addition to noticing the effect of oxygen on combustion, Priestley later noted the new gas's biological role. He placed a mouse in a jar of oxygen, expecting it would survive for 15 minutes maximum before it suffocated. Instead, the mouse survived for a whole hour and was none the worse for it.

Antoine Lavoisier carried out similar experiments to Priestley's and added to our knowledge enormously by discovering that air contains about 20 percent oxygen and that when any substance burns, it actually combines chemically with oxygen.

Lavoisier also found that the weight of the gas released by heating mercury oxide was identical to the weight lost by the mercury oxide and that when other elements react with oxygen their weight gain is identical to the weight lost from the air. This enabled Lavoisier to state a new fundamental law: the law of the conservation of matter; "matter is conserved in chemical reactions" or, alternatively, "the total mass of a chemical reaction's products is identical to the total mass of the starting materials." In addition to these achievements, it was Lavoisier who first gave the element its name *oxygen.*

Pre-lab:

Oxygen is a highly_________________ element and is capable of combining with most other elements. It is required by most living organisms and for most ________________ reactions in which heat and light are produced.

Objective: To test for the presence of oxygen in a chemical reaction.

Materials:

3% hydrogen peroxide solution, manganese dioxide, test tube, wooden splint, matches, safety goggles

Procedure

1. Pour 3mL of hydrogen peroxide (H_2O_2) into a test tube.
2. Add a pea-sized amount of manganese dioxide (MnO_2) to the test tube.
3. Observe the test tube for about 1 minute.
4. When instructed by your teacher, set a wooden splint on fire.
5. Blow the splint out after 5 seconds and immediately plunge the glowing splint into the mouth of the test tube. Avoid getting the splint wet.

Observations:

Describe the change in matter that occurred in the test tube. What evidence indicates that oxygen was produced?

Analysis:

Fill in the following information about oxygen:

Element Symbol	Group number	State of matter(s,l,g)	Metal,nonmetal,metalloid?	Density g/mL	MP (˚C)	BP (˚C)

Interesting Facts about Oxygen

- Air is 78 percent nitrogen and 21 percent oxygen. Oxygen is about twice as soluble in water as nitrogen. If it had the same solubility as nitrogen, much less oxygen would be present in seas, lakes and rivers, and life would be very different.
- Almost two-thirds of the weight of living things comes from oxygen, mainly because living things contain a lot of water and 88.9 percent of water's weight comes from oxygen.
- Oxygen (O_2) is unstable in our planet's atmosphere and must be constantly replenished by photosynthesis in green plants. Without life, our atmosphere would contain almost no O_2.
- If we discover any other planets with atmospheres rich in oxygen, we will know that life is almost certainly present on these planets; significant quantities of O_2 will only exist on planets when it is released by living things.
- Just five elements make up over 90 percent of the weight in the Earth's crust. Almost half of the weight of the crust comes from oxygen. (Silicon, aluminum, iron and calcium are the other four main elements in the crust.)
- Oxygen is made in stars which have a mass of five or more Earth suns when they burn helium and carbon or just carbon in nuclear fusion reactions. Oxygen is part of the 'ash' formed by these nuclear fires.
- Oxygen is the third most abundant element in the universe.
- Green and red colors in the aurora borealis (and australis) are caused by oxygen atoms.
  Highly energetic electrons from the solar wind split oxygen molecules high in earth's atmosphere into excited (high energy) atoms.
  These atoms lose energy by emitting photons, producing awe-inspiring light shows.
  These are usually polar displays, because solar electrons accelerate along our planet's magnetic field lines until they hit the atmosphere in the Polar Regions.

Lab activity: Periodic Trends in Reactivity

Background: The structure of the periodic table is such that elements with similar properties are aligned vertically in columns called "groups". As you will learn in class, this leads to smoothly varying trends in properties such as ionization energy and atomic radius as one moves both down the periodic table within a specific group or as one moves horizontally along a given row in the periodic table. The reactivity of the elements also follows well-defined trends both within the group and across a given row. In this experiment, you will explore these trends in reactivity for the elements. Elements in the Periodic Table are organized by increasing atomic number. As atomic number increases so does the number of electrons. Electrons, and specifically valence electrons, are important in determining how an atom interacts with other atoms. The elements in a group (vertical column) have similar properties because they have valence electrons in similar configurations. The elements in the periodic table are divided into categories. Not only is this system useful for finding element but much can be predicted about an element based on its position on the periodic table.

Objective: To explore the reactivity trends of metals in groups and periods of the periodic table.

Pre-lab:

1. In general, where are metals located on the periodic table?

2. What are the names of two metal families?

3. What element is in Group 3 and in the 3rd period?

Safety: Goggles, aprons

Procedure:

Part 1: Trends in Properties within Groups

1.) Place a small strip of magnesium in a test tube and cover with water. Look closely and observe what happens

2.) Place a small piece of calcium in a test tube with several milliliters of water. Record your observations.

Part 1: Trends in Properties within Groups

Metal	Observations: Reactivity in water
Magnesium	
Calcium	

Analysis:

1. What might be a reason for the difference in behavior between magnesium and calcium when placed in water? (Hint: lithium, sodium, and potassium are also progressively more reactive).

Part 2 - Activity Series of Some Metals in HCl

1. Obtain a small sample of zinc and tin. You may reuse the Mg from Part 1. Dump out the water from the test tube containing the magnesium but keep the magnesium in the test tube. Place each metal sample in a separate tube.

2. Add a small amount of dilute HCl to each test tube, just enough to cover the sample. Record your observations.

Part 2 - Activity Series of Some Metals in HCl

Metal	Observations: Reaction in HCL
Magnesium	
Zinc	
Tin	

Analysis:

1. List the three metals from most reactive to least reactive. Use data from your lab to support your answer.

2. In general, is there a relationship between the locations of metals on the Periodic Table and their relative activity? Explain why.

Part 3 - Density Trends in a Group

Silicon (Si), tin (Sn), and lead (Pb) are all in the same group. The density of tin is about 7.28 g/cm3 and the density of Pb is 11.34 g/cm3. Based on this trend, what do you estimate the density of silicon to be?

Estimate: ______________________

Determine the density of silicon. Use the water displacement technique to find the density.

Density of Silicon Data

Mass of Silicon sample (g)	
Volume of water before adding sample (mL)	
Volume of water after adding sample (mL)	
Volume of sample of silicon (mL)	
Density of Silicon (g/mL)	

Analysis:

1. Do your results support estimate? Explain.

Conclusion Questions:

1. What can you conclude about the reactivity of metals as you move down a column or group in the periodic table?

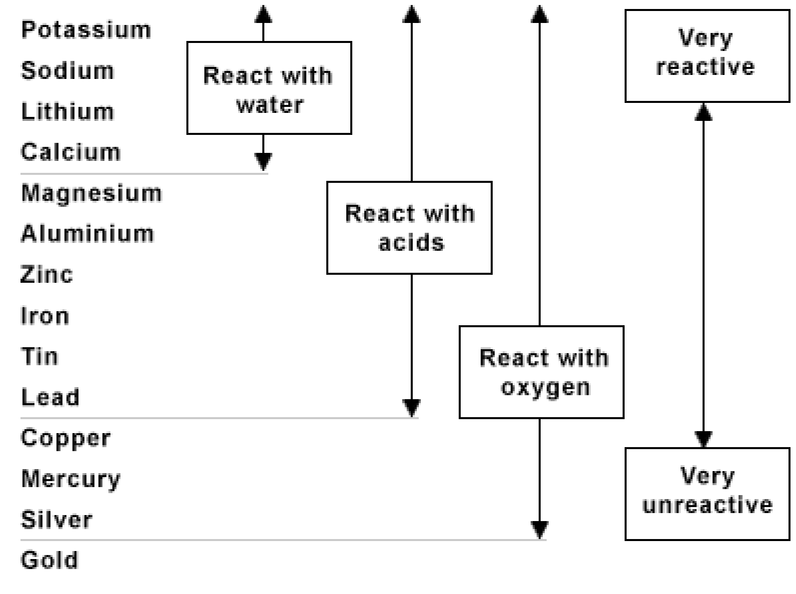
2. What can you conclude about the reactivity of metals as you move across a period?

3. Arrange each set of the following metals in order from least to most reactive using conclusions you just made.

Metals	Order of reactivity (Most reactive to least reactive)
Fr, Na, Cs	
Rb, Ga, Fr	

4. Which is the most reactive metal in the periodic table? Explain. Would you expect this metal to be found in its unreacted elemental form? Explain.

5. The following is a reactivity chart found on in the Internet.



Do your results and conclusion agree with the information found on this chart?

Lab activity :Element Investigation

Background: Many elements on the periodic table occur naturally in various states (solid, liquid, gas) representing a variety of colors. Some elements look similar to each other while other elements have a very different appearance. The periodic table has eighteen vertical columns called groups and seven horizontal rows called periods. Several groups have specific names. Group 17 is called halogens, Group 18 is called noble or inert gases, Group 1 is called the alkali metals and Group 2 is called the alkaline earth metals. The table can also be classified into the groupings of metal, nonmetal and metalloid. The metalloids sit on the “staircase” dividing the metals on the left from the nonmetals on the right. In this lab, a variety of elements will be observed in order to become familiar with their physical characteristics.

Procedure:

1. Visit each lab station and observe the color and state of each element and record in the data table below.

2. Use the periodic table in order to fill in the columns for symbol, group number, and type of element (metal, nonmetal, metalloid).

3. Use the reference table to find the density, melting point, and boiling point. Give the density to two decimal places and record the melting and boiling points to the nearest whole number.

<u>**Element**</u>	<u>**Symbol**</u>	<u>**Group number**</u>	<u>**Color of element**</u>	<u>**State of element (s,l,g)**</u>	<u>**Metal,nonmetal, metalloid?**</u>	<u>**Density**</u>	<u>**Melting point**</u>	<u>**Boiling point**</u>
Zinc								
Nitrogen								
Silicon								
Magnesium								
Oxygen								
Iron								
Aluminum								
Sulfur								
Hydrogen								
Copper								
Helium								
Lead								
Carbon								
Tin								

Conclusion:

1. What is the name given for the horizontal row on the periodic table?

2. What is the name given for the vertical column on the periodic table?

3. What group is on the "staircase" of the periodic table?

4. What is the name for the group numbered 7A ot 17?

5. What is the name for the group 8A or 18?

6. What is the name for the group number 1A or 1?

7. What is the name of the group numbered 2A or 2?

8. Water has a density of 1.0 g/mL, which group has the highest percentage of elements that would sink if placed into water?(metals or nonmetals)

9. Metals and metalloids typically occur in what state?(s,l,g)

10. What element occurs as a yellow solid?

11. What element is prone to rusting?

12. What element is used for water heating pipes?

13. What element is used at home to cover food?’

14. What element is used to fill balloons and is a colorless gas?

15. What element is black and solid and can be used in a BBQ grill?

Fill in the blanks with the choice that best completes the sentence.
Choices: metals, nonmetals, metalloids

16. Some________have very low boiling points.
17. Many_________________have very high melting points.
18. _________________exhibit properties of both metals and nonmetals.
19. __________________occur in a variety of states and colors.
20.__________________have luster (shiny).