Name Completed Notes Hour

Unit 5 – Periodic Trends

OBJECTIVES

1. I can predict the general trends in atomic radius, first ionization energy, and electronegativity of elements using the periodic table.
    a. I can compare size of atoms across periods and down groups.
    b. I can compare ionization energy across periods and down groups.
    c. I can explain where the elements with the highest electronegativities and lowest are located on the periodic table.
    d. I can pick 3 elements and put them in order by increasing atomic radius. I can pick a different 3 and order by decreasing atomic radius.
    e. I can pick 3 elements and put them in order by increasing ionization energy. I can pick a different 3 and order by decreasing ionization energy.
2. I can identify metals, nonmetals, and metalloids using the periodic table.
    a. I can explain how the periodic table is divided.
    b. I can explain why hydrogen's placement is an exception to the rule.
    c. I can name the 6 metalloids.
3. I can identify elements with similar chemical and physical properties using the periodic table.
    a. I can list the characteristics of alkali metals.
    b. I can list the characteristics of alkaline earth metals.
    c. I can list the characteristics of halogens.
    d. I can list the characteristics of noble gases.
4. I can predict if the bonding between two atoms of different elements will be primarily ionic or covalent.
    a. I can identify what type of bond will be formed between a metal and a nonmetal.
    b. I can identify what type of bond will be formed between two nonmetals.

VOCABULARY (I can define/describe the following terms in my own words)

- Actinides
- Alkali metals
- Alkaline Earth metals
- Electronegativity
- First ionization energy
- Group
- Halogens
- Ionization energy
- Lanthanides
- Main-group elements
- Metalloids
- Metals
- Mendeleev
- Nonmetals
- Noble gases
- Period
- Periodic law
- Shielding
- Transition metals

Alkali Metal Video Demo

DIRECTIONS: Watch the demonstration and record your observations under the following categories. Be specific and critical in your thinking.

I see...

I think...

I wonder...

Dimitry Mendeleyev

Hailed as the greatest chemical mind since Lavoisier, Dimitry Mendeleyev did important work for industrial and agricultural chemistry, helped regulate Russia's weights and measures, and authored a standard textbook. His most enduring achievement, however, was his periodic law or, as it is better known, the periodic table, which ranks alongside the achievements of Newton and Darwin.

The Fundamental Theme

Born to an impressive mother who ran a glass factory in Siberia to support her family when her husband died, Dimitry Mendeleyev (1834–1907) was the youngest in a large family. A brilliant student, he overcame illness to win a scholarship to study in Germany with Robert Bunsen (of burner fame, see pp. 164–165). In 1861 he returned to Russia to take up a position at St. Petersburg University. Like many others around this period he was preoccupied with uncovering what he called, "the philosophical principles of our science which form its fundamental theme."

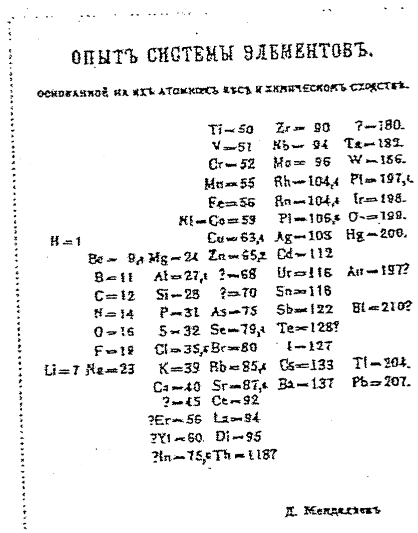
• With his trademark long hair and beard, Mendeleyev cut an imposing figure. He first came to international attention with his landmark 1870 textbook *Principles of Chemistry*, which was translated into many languages.

Working on a new textbook in 1869, Mendeleyev was prompted to consider the issue of whether the elements could be arranged according to some system or law. One of the few people aware of the work of de Chancourtois, Mendeleyev began to play with the order of the elements for himself, noting that the halogens and the oxygen and nitrogen groups of elements could be arranged in a table of ascending atomic weights. Seeking a larger pattern that included all the other elements, he wrote the name and atomic weight of each one on a card and arranged them in vertical lines. After working on the problem fruitlessly for three days he fell asleep and had a celebrated dream: "I saw in a dream a table where all the elements fell into place as required. Awakening, I immediately wrote it down on a piece of paper." His dream table clearly showed that, if arranged according to atomic weight, the elements followed a periodic law (see pp. 154–155).

A Suggested System

His historic paper "A Suggested System of the Elements" showed a table in which the elements were ordered in columns of descending atomic weight, arranged such that each row contained elements with similar properties. What was revolutionary and daring about his scheme was its refusal to adhere to the constraints that had hamstrung previous efforts. Where necessary he put some elements out of order (putting question marks next to their atomic weights) and left gaps where there was no element that fit the pattern. Although breaking one of the cardinal rules of science—namely that theories should be made to fit the evidence, rather than vice versa—this was the precisely the intuitive leap necessary to solve an intractable problem. In effect Mendeleyev was predicting that his theory was right, and that where chemistry disagreed with him, it was science that was wrong.

The true test of a scientific theory is that it makes testable predictions (see p. 83), and Mendeleyev's periodic law did just this. Not only was he able to predict which atomic weights had probably been incorrectly determined, he was even able to predict the existence of hitherto unknown elements, including their likely atomic weights and even their properties. These unknown elements included one between aluminum and indium, which he named eka-aluminum and predicted would have an atomic weight of 68, and an element of atomic weight 70 between silicon and tin that he named eka-silicon (*eka* was Sanskrit for "one"—as in "aluminum, or silicon, plus one").



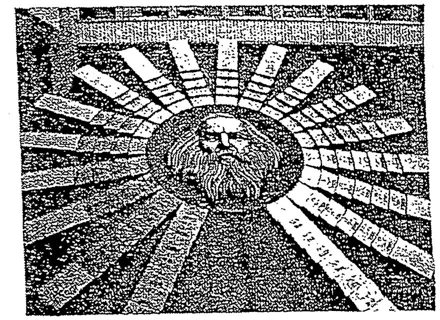
ОПЫТЪ СИСТЕМЫ ЭЛЕМЕНТОВЪ.

ОСНОВАННОЙ НА ИХЪ АТОМНОМЪ ВѢСѢ И ХИМИЧЕСКОМЪ СХОДСТВѢ.

Ti=50 Zr=90 ?=180.
V=51 Nb=94 Ta=182.
Cr=52 Mo=96 W=186.
Mn=55 Rh=104,4 Pt=197,4
Fe=56 Ru=104,4 Ir=198.
Ni=Co=59 Pl=106,6 Os=199.
H=1 Cu=63,4 Ag=108 Hg=200.
Be=9,4 Mg=24 Zn=65,2 Cd=112
B=11 Al=27,4 ?=68 Ur=116 Au=197?
C=12 Si=28 ?=70 Sn=118
N=14 P=31 As=75 Sb=122 Bi=210?
O=16 S=32 Se=79,4 Te=128?
F=19 Cl=35,5 Br=80 I=127
Li=7 Na=23 K=39 Rb=85,4 Cs=133 Tl=204.
Ca=40 Sr=87,6 Ba=137 Pb=207.
?=45 Ce=92
?Er=56 La=94
?Yt=60 Di=95
?In=75,6 Th=118?

Д. Менделѣевъ

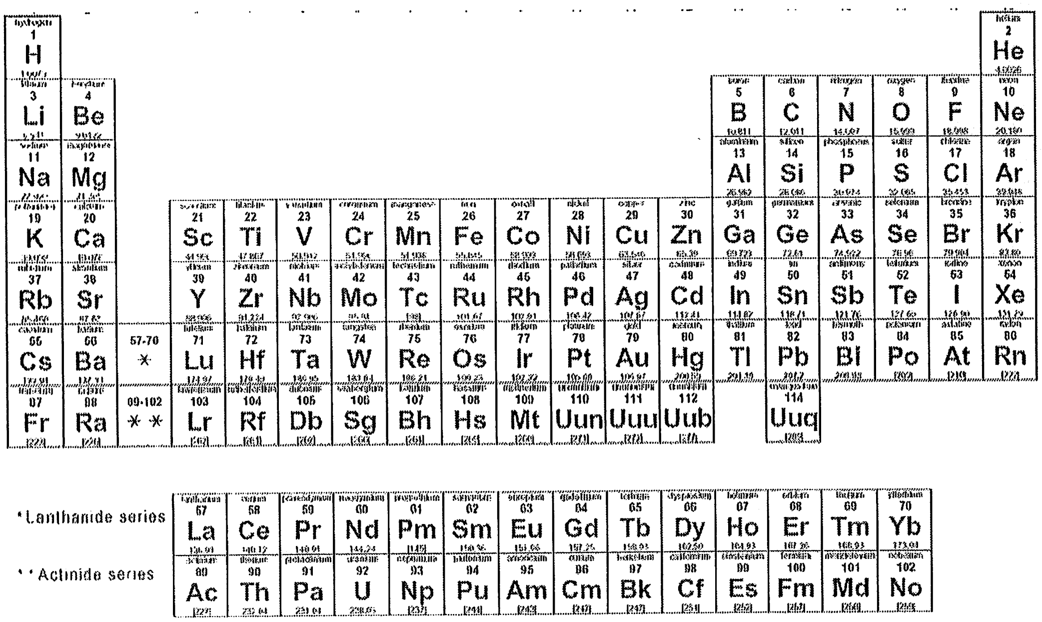
• The original Russian version of Mendeleyev's periodic table, which is oriented perpendicular to modern versions, so that the periods run vertically. Note the question marks next to elements that he predicted but which had not yet been discovered.



• This monument to the periodic table can be found at the Slovak University of Technology in Bratislava, Slovakia. Dimitry Mendeleyev's distinctive portrait occupies center stage.

Confirming his confidence that the table was accurate was the correspondence between each of his horizontal rows—or families—and the valence (see p. 27) of the elements it contained. Reading vertically along the table, the valencies went from 1 on the lithium row up to 4 on the carbon row and back down to 1, giving a pattern of 1, 2, 3, 4, 3, 2, 1—a periodic rise and fall. Here was the periodic law he had been looking for. Although there were inconsistencies, he was confident enough to overlook these: "Although I have had my doubts about some obscure points, yet I have never doubted the universality of this law, because it could not possibly be the result of chance."

Metal, Nonmetal, Metalloid Notes



Properties of metals

- Shiny = lusterous
- Malleable - flatened into sheets
- ductile - pulled into wire
- good conductors of electricity and heat
- Can do metallic bonding
- gives away e⁻

Why are metals such good conductors?

They freely give up their electrons which transfers heat better and causes flow of electrical current.

Properties of Nonmetals

- Dull
- Brittle
- Poor Conductors
- Can be gaseous at
- Does covalent bonding
- prefers to recieve e⁻

Nonmetals are good at forming bonds and sharing electrons.

Found in organic molecules in the bodies of organisms

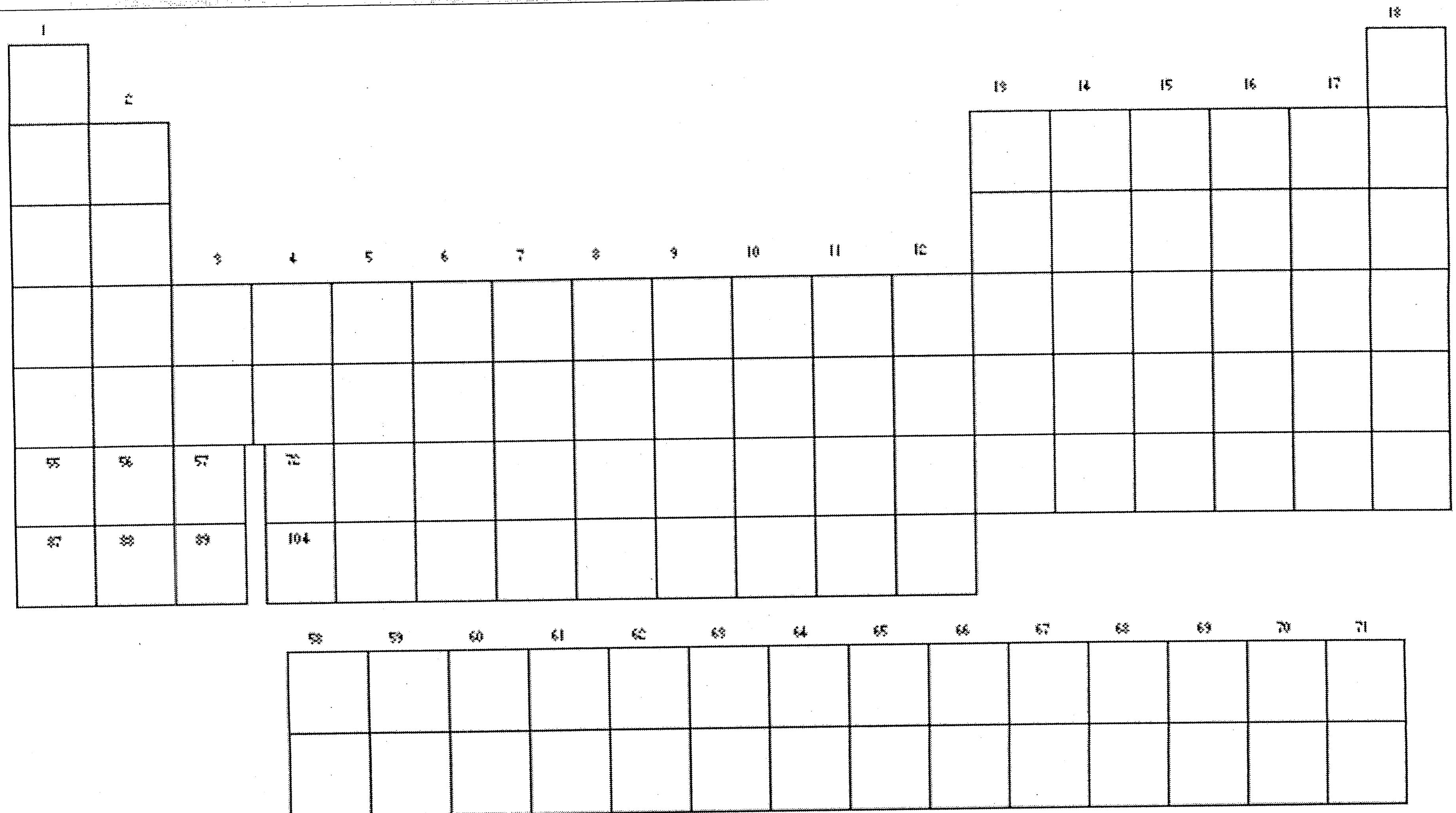
Metalloids (Semi-conductors)

Have some properties of metals and some like nonmetals

What are semi-conductors used for?

Computer processors, Photovoltaic cells

Overview of the Periodic Table



Label or color the periodic table with the following labels.

Period
Group
Metals
Nonmetals
Metalloids

Transition metals
Main-group Elements
Alkali metals
Alkaline Earth metals
Lanthanides

Actinides
Halogens
Noble gases
Hydrogen

Properties of Periodic Groups

Match the properties below into the correct categories

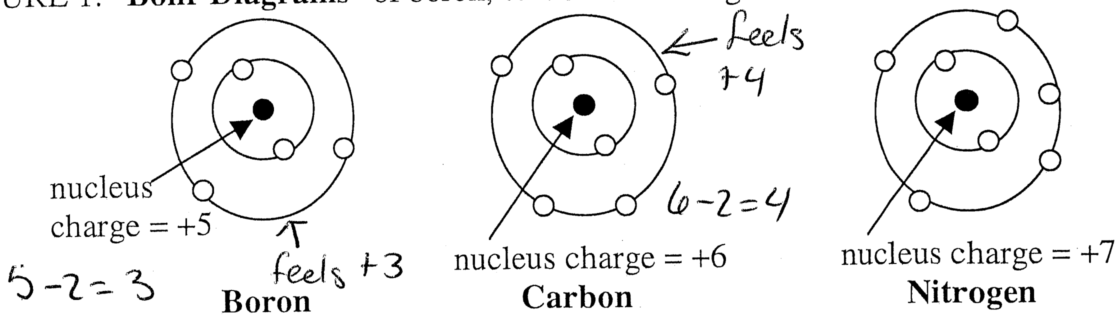
Radioactive
Lose two electrons to form a 2+ ion
Groups 1,2 13-18
Very stable
Elements 90-103
Used in signs, balloons
Named for the 1st element in the series, actinium
In fats, carbohydrates and proteins
Only 1 proton and 1 electron
Excellent conductors of electricity
Not as reactive as groups 1 & 2
Can react with many elements
Combine with metals to form salts
Octet (8) of electrons
Soft, can be cut with a knife
Shiny reactive metals that have irregular electron configurations
Representative elements
Most reactive of the nonmetals
Named for the 1st element in the series, lanthanum
Harder, denser and stronger than alkali metals
Seven electrons in the outermost energy level
Most reactive of the metallic elements
Only one electron in the highest energy level
Reactive, but less than group 1
Electrons fill the d orbital
Inert (does not react) gases
Essential to life
Atomic numbers 58-71
Groups 3-12

Alkali Metals	Alkaline Earth Metals	Transition Metals
• Excellent conductors of electricity • Soft, can be cut with a knife • most reactive of metallic elements • Only 1e⁻ in highest energy level	• Lose 2e⁻ to form a 2+ ion • Harder, denser, stronger than alkali metals • Reactive, but less than group 1	• Not as reactive as groups 1 and 2 • e⁻ fill the d orbital • groups 3-12
Main-group Elements	**Halogens**	**Noble Gases**
• Groups 1, 2, 13-18 • representative elements	• Combine with metals to form salts • 7 e⁻ in outer energy level • Most reactive non-metals	• very stable • Used in signs, balloons • Octet of 8e⁻ • Inert (does not react) gases
Lanthanides	**Actinides**	**Hydrogen**
• Named for 1st element in series Lanthanum • Atomic #'s 58-71 • Shiny, reactive metals with irregular e⁻ configurations	• Elements 90-103 • Named for 1st element in series Actinium • Radioactive	• In fats, Carbs and protein • Only 1 proton & 1e⁻ • Can react with many elements • Essential to life

POGIL #1 – Atomic Radius Trend

Information: Shielding

FIGURE 1: "**Bohr Diagrams**" of boron, carbon and nitrogen



Because the nucleus is positively charged, it exerts an attractive force on the electrons. However, the three electrons in boron's outer energy level do not feel the full +5 attraction from the 5 protons in boron's nucleus. Before the +5 attraction gets to the outer energy level it gets partially cancelled (or **"shielded"**) by the two electrons in the first energy level. The two electrons in the first energy level weaken the attractive force by two. Therefore to the outer energy level it only "feels" like a +3 charge rather than a +5 charge from the nucleus.

Consider the diagram of carbon. An electron in the outer energy level only "feels" a charge of +4 coming from the nucleus because the two electrons in the first energy level shield two of the positive charges from the nucleus.

Critical Thinking Questions

1. How large is the charge that the second energy level of nitrogen "feels" from the nucleus?

   7-2=5   2nd level of e^- "feel" +5 charge

2. Why does the first energy level in each of the three above diagrams only contain two electrons?

   Because its 1s and 1s can only hold $2e^-$

3. How many electrons can fit in the second energy level of any atom?

   $8e^-$ total 2 from 2s and 6 from 2p

4. How many electrons can fit in the third energy level?

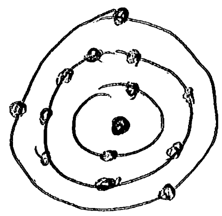
   $18e^-$ $3s^2 3p^6$ and $3d^{10}$

5. How many energy levels does aluminum have? How many electrons should be in each energy level?

$1s^2 = 2e^-$ $2s^2 2p^6 = 8e^-$

Al has 3 energy levels $3s^2 3p^1 = 3e^-$

6. Draw a Bohr diagram for aluminum similar to those above.



7. Explain why the second energy level of aluminum only feels a +11 attraction instead of a +13 attraction from aluminum's electrons.

$13p^+$ 13 − 2 = 11 → 2nd level "feels" +11 attraction to nucleus

↑ 1s e⁻ shield protons in nucleus

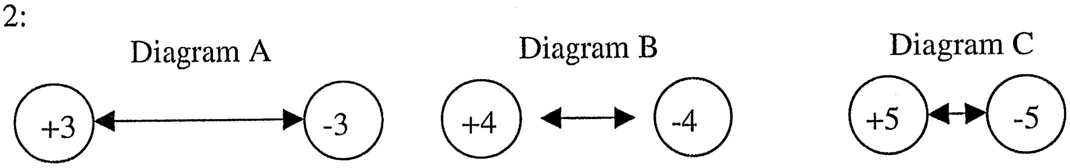
8. How large is the charge that the third energy level of an aluminum atom "feels" from the nucleus?

13 − 2 − 8 = +3 → 3rd level "feels" +3 attraction to nucleus

Information: Charge and Distance

As you know, opposite charges attract. Examine the following diagrams of charged metal spheres.

FIGURE 2:



The attraction between the two charged metal spheres in each diagram is represented by an arrow. The metal spheres are pulled closer together in diagram C because of the +5 to -5 attraction is stronger than the +4 to -4 attraction in Diagram B and the +3 to -3 attraction in Diagram A.

☆ Electrons behave the same way as the metal spheres are depicted in Figure 2. Consider the Bohr diagrams of boron, carbon and nitrogen in Figure 1. Recall that Boron's outer electrons feel a +3 attraction from the nucleus. Carbon's outer electrons feel a +4 attraction. In question 1, you found out that nitrogen's outer electrons feel a +5 attraction.

← (*) Know this

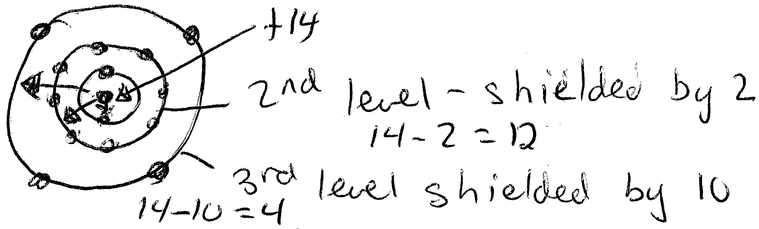
This attraction between the nucleus and outer energy level determines the size of the atom. If the attraction is strong the atom is small; if the attraction is weak, the atom spreads out and is larger.

Critical Thinking Questions

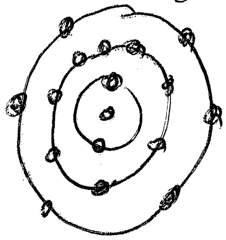
9. Which atom is larger: nitrogen or carbon? Why?

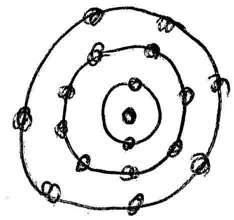
Carbon is larger because its e⁻ are less attracted to the nucleus than Nitrogen's e⁻.

10. In a silicon atom, the force of attraction from the nucleus to the outer energy level is +4. Using a Bohr diagram of a silicon atom as an illustration, explain in detail why this is true.



11. Draw Bohr diagrams for sulfur and chlorine.

S 

 Cl

12. a) Find the size of the charge attraction between the nucleus and outer energy level for sulfur and for chlorine. S = 16 - 10 = +6   Cl = 17 - 10 = +7

b) Which atom do you predict to be larger: (sulfur) or chlorine?

c) Explain, in detail, your reasoning to part b.

Sulfur's outer e⁻ will feel a little less attracted to the nucleus and will NOT be pulled in as close as Cl's

13. Notice and compare the locations of boron, carbon and nitrogen on the periodic table. Now compare their sizes. Do the same with sulfur and chlorine. There is a general trend in size as you proceed from left to right across the periodic table. What is this trend? In other words, how do atoms in the same row of the periodic table compare to each other in size?

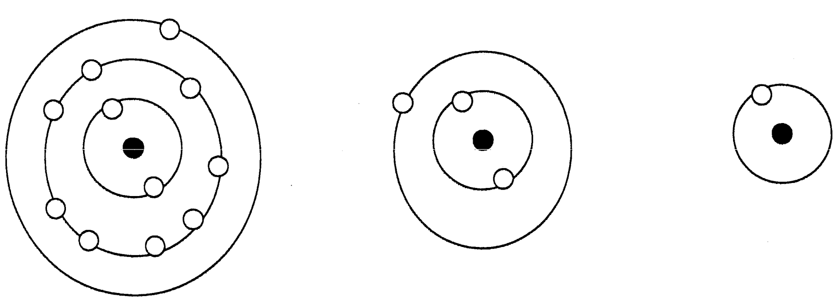
(*) As you go from left to right, Atomic Radius DECREASES

Information: Bohr Diagrams and the Size of Atoms

Examine the following "Bohr Diagrams" of three atoms from the periodic table.

FIGURE 3

Atom A Na   Atom B Li   Atom C H



Critical Thinking Questions

14. Give the name and atomic number of each atom from Figure 3.

	Atom A	Atom B	Atom C
Name of the element	Na	Li	H
Atomic number	11	3	1

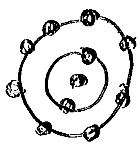
15. a) Concerning atoms A, B and C, what is similar about their location in the periodic table?

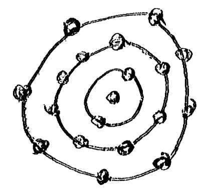
All in the Same group (column)

b) In atoms A, B, and C compare the force of attraction from the nucleus to the outer level of electrons.

Na $11-10=+1$ Li $3-2=+1$ H $+1$ All have the same level of attraction

16. Draw Bohr diagrams for neon and argon.


Ne


Ar

17. a) What is similar about the location of neon and argon in the periodic table

Same group (column)

b) Compare the force of attraction between the outer level electrons and the nucleus for neon and argon. Ne $10-2=8$ Ar $18-10=8$

c) Using your answers to 15b and 17b, what can be said about elements in the same column and the force of attraction between their outer energy level and nucleus?

Within a column, all elements have the same level of attraction with the outer e⁻

18. Atom A is larger than atom B. The attraction between the nucleus and outer level electrons is equal in atoms A and B, so what other reason could there be for Atom A's larger size? Propose an explanation based on that structure of atoms A and B.

Atom A has more energy levels than Atom B

19. Which is larger—neon or argon? Why is this atom the largest?

Argon because it has a 3rd energy level

20. In general, there is a trend in the sizes of atoms as you move down a column of the periodic table.

a) What is this trend? Atomic size increase

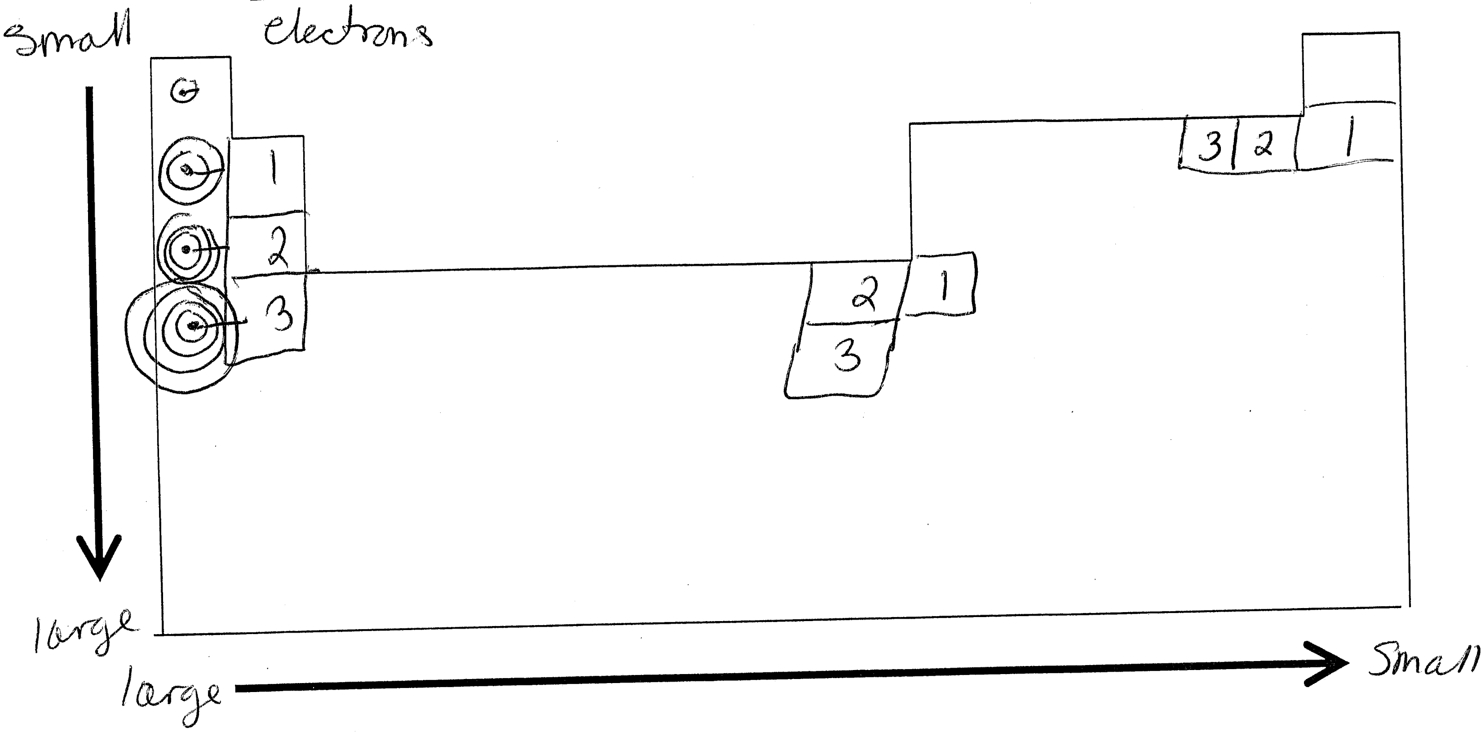
b) Why does this trend exist? (Explain the basis for the trend.)

Because as you go down the column, additional energy levels are added

21. Order the following lists of elements in order from smallest to largest.

a) K, As, Br b) P, Sb, N c) S, Ca, Mg, Cl

Atomic Radius – the distance from nucleus to outermost electrons

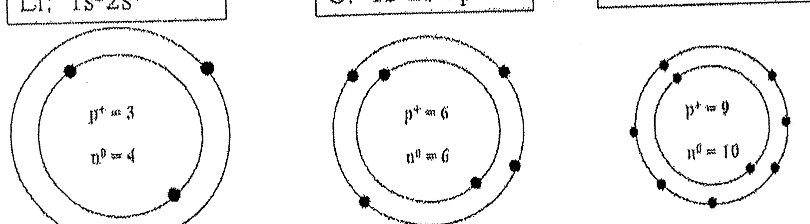


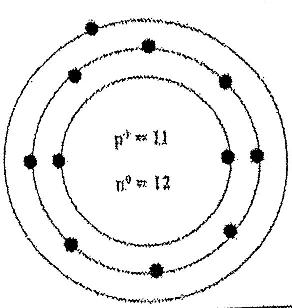
Summarize the information from POGIL #1

Li: $1s^2 2s^1$

C: $1s^2 2s^2 2p^2$

F: $1s^2 2s^2 2p^5$





Sodium: $1s^2 2s^2 2p^6 3s^1$

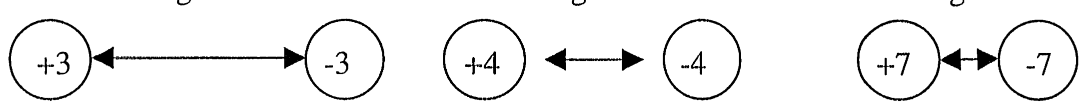
As nucleus increases in charge, electrons are more attracted to it and are held more closely

POGIL #2 – Ionization Energy Trend

Information: Separating Charges

Examine Figure 1 below where there are three pairs of metal spheres that have different amounts of charge on them. The spheres in diagram C are closer than the others because they have the strongest attraction.

FIGURE 1: Attraction between metal spheres.

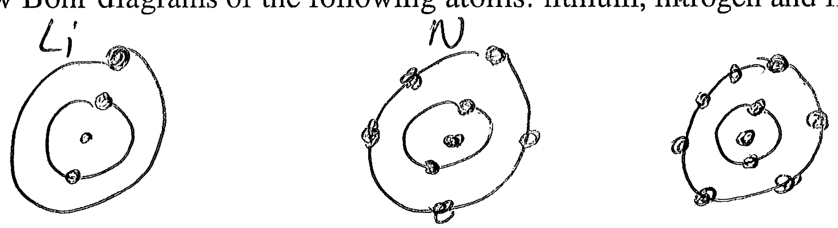


Critical Thinking Questions

1. Which would be harder to separate: the two spheres in Diagram A or the two spheres in Diagram B? Why?

B would be harder to seperate then A because they are closer together and have a stronger attraction.

2. Draw Bohr diagrams of the following atoms: lithium, nitrogen and fluorine.



3. For each of the atoms in question two compare the attraction between the nucleus and the outer level of electrons. Which atom has the strongest attraction between the nucleus and outer electrons?

Li $3-2=+1$
N $7-2=+5$
F $9-2=+7$

F has the strongest attraction (+7) of nucleus to outer electrons

4. Which would be more difficult: if you wanted to remove an electron from an atom of fluorine or from an atom of nitrogen?

More difficult to remove an electron from F

5. Would it be easier to remove an electron from lithium or nitrogen?

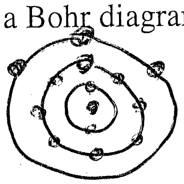
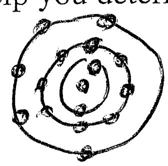
More ~~easily~~ easy to remove e^- from Li

Information: Ionization Energy

The amount of energy that it takes to completely remove an electron from an atom is called **ionization energy**. The first ionization energy is the energy required to remove one electron from an atom's outer energy level. The second ionization energy is the energy needed to remove a second electron from the energy level. The second ionization energy is always higher than the first ionization energy. Because noble gases have eight electrons in their outer energy level, they are very stable and therefore it takes a very high amount of energy to remove an electron from a noble gas.

Critical Thinking Questions

6. Which would have a higher first ionization energy: phosphorus or aluminum? (You may want to draw a Bohr diagram to help you determine the answer.)

Al   P

Al 13-2-8 = +3

P 15-2-8 = +5 Higher

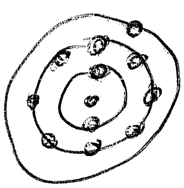
7. a) Phosphorus and aluminum are in the same row of the periodic table. Lithium, nitrogen and fluorine are also in the same row. Using your answers to questions 3, 4 and 6 what do you notice about the ionization energy of elements proceeding from left to right across a row of the periodic table? Does the ionization energy increase or decrease as you go across a period?

from L to P, ionization energy increases across a period

b) Explain **why** you believe this trend exists.

e^- are held more tightly (atomic size decreases) across a period so they are more difficult to seperate, requiring more energy to do so

8. Draw a Bohr diagram of sodium. Do you expect the first ionization energy to be high or low for sodium?



Low because outer e^- feels only +1 attraction to nucleus

Information: Trend in Ionization Energy in Groups

Consider the following figure of diagrams of two magnets that you wish to separate.

FIGURE 2: Separating Magnets

Diagram D   Diagram E

Critical Thinking Questions

11. Would it be easier to separate the magnets in Diagram D or those in Diagram E in Figure 2? Assume that each magnet is attracted to the other and that the size of the attraction is the same. Take only the distance between magnets into consideration.

Easier to seperate E than D

12. How does the distance between the outer level of electrons and the nucleus in phosphorus compare to the distance between the outer level of electrons and the nucleus in nitrogen?

Phosphorus has 1 more energy level, therefore its outermost e^- are farther from the nucleus than Nitrogen's

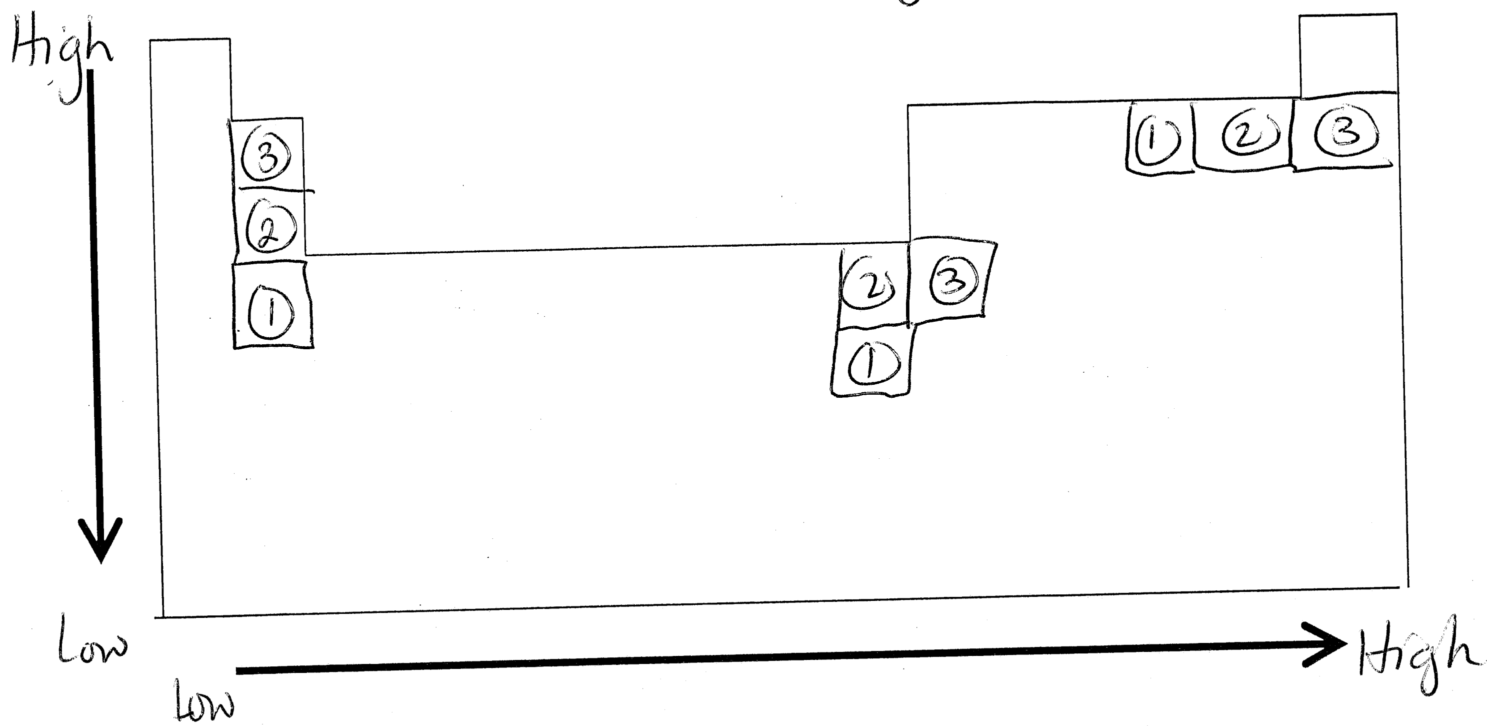
13. Based on your answer to question 12, would it be easier to remove an electron from nitrogen or from phosphorus?

Easier to remove an e^- from phosphorus

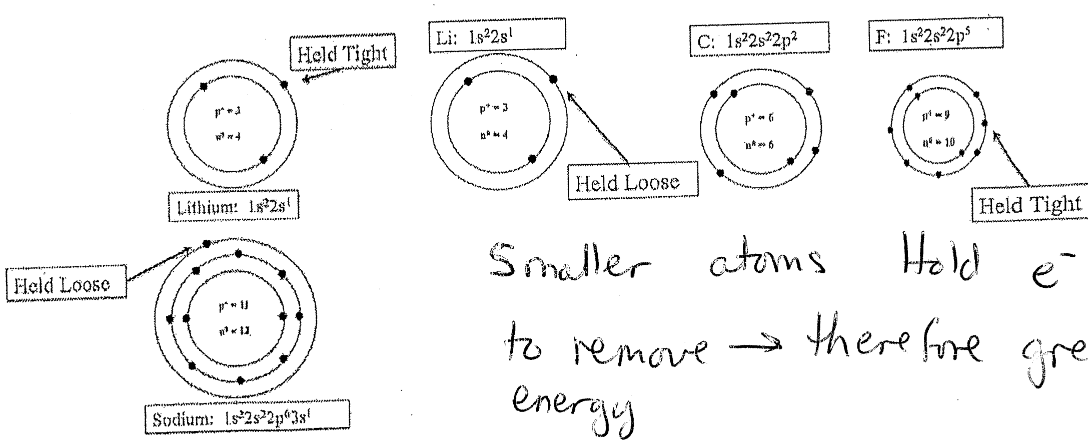
14. Nitrogen and phosphorus are in the same column on the periodic table. From your answers to questions 12 and 13 what happens to the ionization energy as you move down a column in the periodic table?

As you go down a group, ionization energy decreases because it becomes easier to remove an e^-

1st Ionization Energy – the amount of energy required to remove an electron from the outermost energy level of an atom



Summarize the information in POGIL #2



Smaller atoms Hold e^- tightly = Harder to remove → therefore greater Ionization energy

What is the relationship between first ionization energy and atomic size?

As atomic size ↑, 1st Ionization energy ↓

Periodic Trends Lab

Introduction: The periodic table is the most recognized symbol of chemistry across the world. It is a valuable tool that allows scientists not only to classify the elements, but also to explain and predict their properties. Similarities and differences among the elements give rise to periodic trends, both across rows and within columns of the periodic table. Recognizing periodic trends in the physical and chemical properties of elements is key to understanding the full value of the periodic table.

Background:

The modern periodic table lists more than 112 elements, of which 92 are naturally occurring. Of these 92 elements, the eight most abundant elements together account for more than 98% of the mass of Earth's crust, oceans, and atmosphere. Two of the eight most abundant elements on Earth are calcium and magnesium, which are present in both mountains and minerals, seawater and seashells. Calcium and magnesium are members of Group 2 family of elements, the alkaline earth metals. Elements that share similar properties are arranged together within vertical columns, called groups or families, in the periodic table.

The *alkaline earth metals* – beryllium, magnesium, calcium, strontium, barium, and radium – are a reactive group of metals. Because they combine easily with many other elements, the alkaline earth elements are not found on Earth in the form of their free metals. They exist in nature in the form of ionic compounds, such as calcium carbonate, $CaCO_3$. Calcium carbonate occurs naturally in limestone, marble, as well as seashells.

The alkaline earth metals react with water, acids and bases, and many nonmetals, including oxygen, sulfur, and the halogens. The ease with which a metal reacts is called the activity of the metal. By comparing how fast or how vigorously different metals react, it is possible to rank the metals in order from most active to least active. This ranking – called the *activity series* of the metals – shows clear periodic trends, both within a group and across a period of elements in the periodic table.

Periodic trends are also observed in the solubility of alkaline earth metal compounds. Although their compounds with halide anions are all water soluble, alkaline earth metals compounds with other anions do not always dissolve in water. The solubility of alkaline earth metal compounds with different anions can be tested by carrying out *double replacement reactions.* Reaction of calcium chloride with sodium carbonate, for example, leads to an exchange of anions between the two metals to give calcium carbonate, which is insoluble in water and precipitates out as a solid when the two solutions are mixed. The chemical equation for this reaction is shown below, where abbreviations (aq) and (s) refer to aqueous solutions and solid precipitates, respectively.

$$CaCl_2\,(aq) + Na_2CO_3\,(aq) \longrightarrow CaCO_3\,(s) + 2\,NaCl\,(aq)$$

calcium chloride + *sodium carbonate* → *calcium carbonate* + *sodium chloride*

Purpose: The purpose of this experiment is to identify periodic trends in the activity of alkaline earth metals. In Part A, the reactions of magnesium, calcium, and aluminum with water and acids will be compared in order to determine the trend in metal activity within a group (Mg vs. Ca) and across a period (Mg vs. Al) in the periodic table. In Part B, you will observe another family of elements, the halogens and the reactivity of their ions with two different chemicals. In Part C, the solubility of magnesium, calcium and barium compounds will be studied and used to identify unknown alkaline earth metal.

Safety Precautions: *Calcium and Magnesium are reactive, flammable solids and possible skin irritants. Use forceps or a spatula to handle these metals. Hydrochloric acid (HCl) is toxic by ingestion and inhalation and is corrosive to skin and eyes; avoid contact with body tissues. Strontium and barium compounds are toxic by ingestion. Potassium iodate solution is moderately toxic and a strong irritant. Silver nitrate solution is highly toxic and causes burns; it will stain skin and clothing. Calcium reacts with water to evolve flammable hydrogen gas; skin irritant. Magnesium is a flammable solid. Ammonia water is moderately toxic by ingestion and inhalation, is irritating to eyes, and is a serious respiratory hazard. Sodium bromide and sodium iodide are slightly toxic by ingestion and inhalation. Avoid contact of all chemicals with eyes and skin. Wear chemical splash goggles at all times and wash hands thoroughly with soap and water before leaving the laboratory.*

Part A. Activity of Alkaline Earth Metals

Materials

Aluminum foil, 2-cm square, 2
Calcium, turnings, Ca, 0.1 gram
Magnesium, ribbon, Mg, 2-cm piece
Hydrochloric acid solution, 0.5 M, HCl, 40 drops
Thermometer
Litmus paper, red, 3 pieces
Pipets
Forceps
Reaction plate, 24-well
Matches

Procedure

1. In a weighing dish, obtain 2 small pieces of calcium turnings.
2. Obtain two small pieces of magnesium ribbon, approximately 1-cm each, and a short piece of aluminum foil.
3. Place a 24-well reaction plate on top of a sheet of white paper. Note that each well is identified by a unique combination of a letter and a number, where the letter refers to the horizontal row and the number to a verticle column.
4. Use a pipet to add 20 drops of distilled water to wells A1–A3.
5. Test the water in wells A1-A3 with a piece of red litmus paper and record the initial color for this "litmus test" in Data Table A.
6. Use forceps to add one piece of calcium to well A1.
7. Use forceps to add one piece of magnesium ribbon to well A2.
8. Tear off a small piece of aluminum foil and roll into a loose ball. Add the aluminum metal to well A3.
9. Observe each well and record all immidiate observations in Data Table A. If no changes are observed in a particular well, write NR (No Reaction) in the data table.
10. Test the water in wells A1-A3 with a piece of red litmus paper and record any color changes for this litmus test in Data Table A.
11. Continue to watch each well for 1-2 minutes. Record any additional observations comparing the rates of reaction in Data Table A.
12. Use a pipet to add 20 drops of 0.5 M HCl to wells C1-C3. Measure and record the initial temperature of the solutions in well C1-C3 in Data Table A.
13. Use forceps to add one piece of calcium to well C1.
14. Use forceps to add one piece of magnesium ribbon to well C2.
15. Tear off a small piece of aluminum foil and roll into a loose ball. Add the aluminum metal to well C3.
16. Observe each well and record all immidiate observations in Data Table A. If no changes are observed in a particular well, write NR in the data table.
17. After 2 minutes, measure the temperature of each solution in wells C1-C3. Record the final temperature of each solution in Data Table A.
18. Is there evidence that a gas is being produced in wells C1-C3? Test the combustion property of the gas by bringing a lit match to the space just above each well C1-C3. Record any observations for this "match test" in Data Table A.
19. Continue to watch each well for 1-2 minutes. Record any additional observations comparing the rates of reaction in Data Table A.
20. Dispose of the well contents in the metal waste beaker. Rinse the reaction plate with water before proceding to Part B.

Part B. Solubility of Alkaline Earth Metals Compounds

Materials

Barium chloride, $BaCl_2$, 0.1 M, 3mL
Calcium chloride, $CaCl_2$, 0.1M, 3mL
Magnesium chloride, $MgCl_2$, 0.1M, 3mL
Strontium chloride, $SrCl_2$, 0.1M, 3mL
Unknown metal chloride solution, 0.1M, 3mL
Potassium iodate, KIO_3, 0.2M, 5mL
Sodium carbonate, Na_2CO_3, 1M, 5mL
Sodium sulfate, Na_2SO_4, 1M, 5mL
Reaction plate, 24-well

Procedure

1. Place the 24-well reaction plate on the black surface of your desk.
2. Referring to Data Table C as a guide, use a pipet to add 20 drops of alkaline earth metal solutions to the appropriate wells, as follows:
   a. Magnesium chloride to wells A1-C1
   b. Calcium chloride to wells A2-C2
   c. Strontium chloride to wells A3-C3
   d. Barium chloride to wells A4-C4
3. Use a clean pipet to add 20 drops of unknown alkaline earth metal solution to wells A5-C5
4. Referring to Data Table C as a guide, use a clean pipet to add 20 drops of testing solution to the appropriate wells, as follows:
   a. Sodium carbonate to wells A1-A5
   b. Sodium sulfate to wells B1-B5
   c. Potassium iodate to wells C1-C5
5. Record observations in Data Table C as follows: if a solid forms in a well, write PPT (precipiate) in the appropriate circle in the data table. If no solid is observed, write NR (no reaction) in the appropriate circle in Data Table C.
6. Dispose of the contents of the reaction plate by rinsing down the drain in the back sink. Thoroughly rinse reaction plate and return to supply counter.

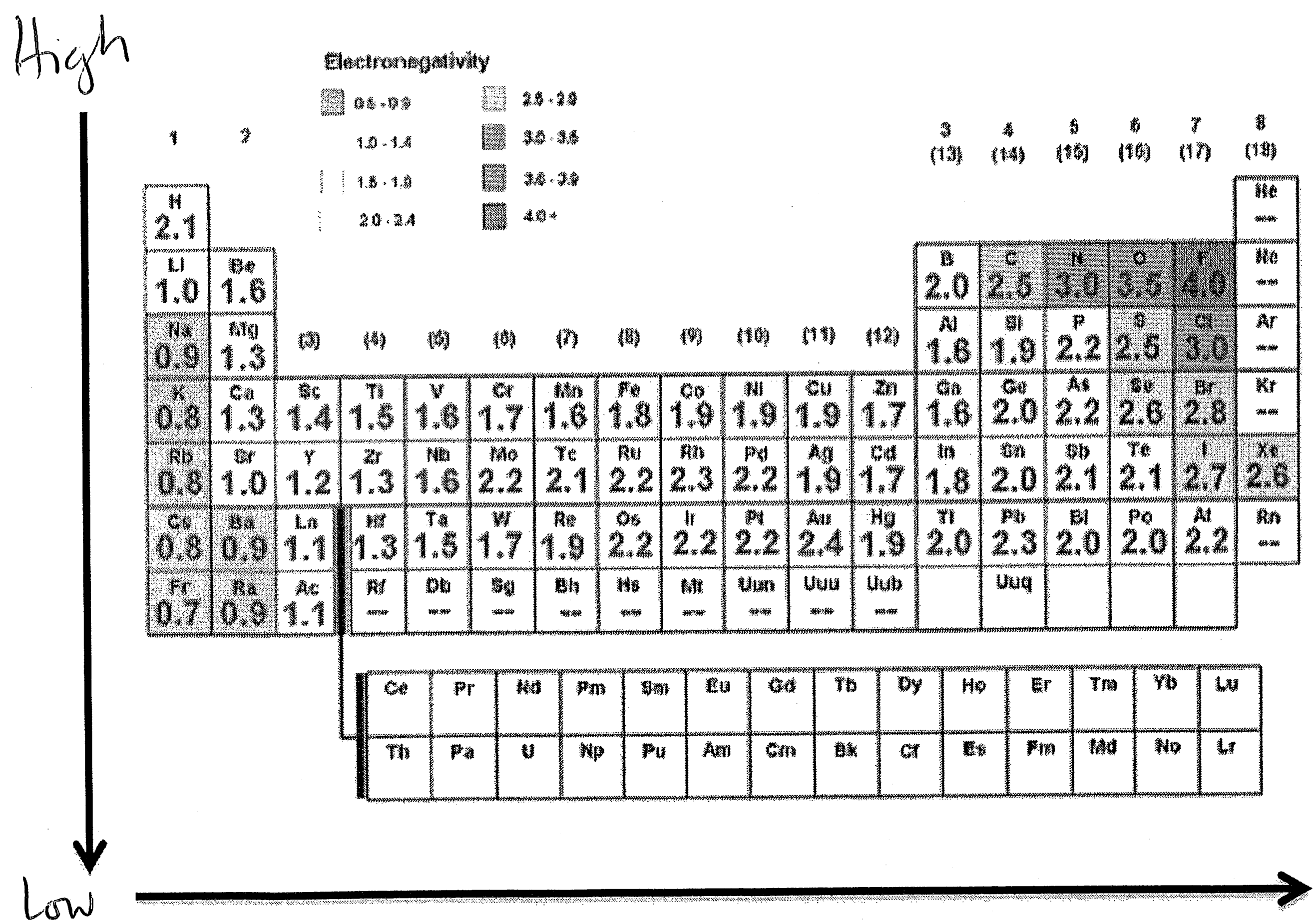
Electronegativity Notes

Electronegativity

- Electronegativity is defined as the ability of an atom to hold bonding electrons to it.
- If an atom needs only to **gain** a few electrons to fill its outer shell, it will have High electronegativity
- If an atom wants to **get rid** of electrons, it will have very Low electronegativity.
- Atoms that want to gain NO electrons (Noble gases) will have no electronegativity values.

Relationship between Ionization energy and Electronegativity

- Low 1st ionization energy = easy to give away an electron... these atoms Do Not want to take on another electron...therefore, Low electronegativity
- High 1st ionization energy = hold their electrons tightly and would be attractive for other electrons as well...therefore, High electronegativity.



elements which combine with metals to form salts and are highly reactive nonmetals, want to gain one electron	the horizontal groupings (rows) of atoms on the periodic table	the energy required to remove one electron from an atom's outer energy level	elements that fill the f sublevel, named for the first element in the series, lathanum
the ability of an atom to hold bonding electrons to it	soft, extremely reactive metals, good conductors of electricity, will give away one electron	law stating that many of the physical and chemical properties of the elements tend to recur in a systematic manner with increasing atomic number	the amount of energy that it takes to completely remove an electron from an atom
the scientist who discovered the periodic law and placed elements in order according to their properties	nonreactive elements (inert gases) and therefore very stable, have a full eight electrons in their outer shell (called an octet)	harder, denser, stronger, and less reactive than alkali metals, will give away two electrons	also called the representative elements, found only in the s and p blocks of the periodic table
elements filling the d orbital, reactive metals in groups 3-12	when the full positive charge of the nucleus is slightly canceled by the negative charge of the inner electron levels and therefore is not "felt" by the outermost electrons	the vertical groupings (columns) of atoms on the periodic table, also known as families	elements that fill the f sublevel, named for the first element in the series, actinium, radioactive

elements to the left of the stair-step line, good conductors of electricity, shiny, malleable, and ductile	elements to the right of the stair-step line, poor conductors of electricity, brittle as solids	elements found along the stair-step line, semiconductors, solid at room temperature, used in electronics	