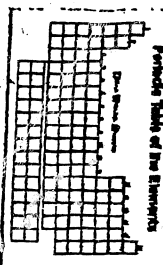


Name: _____

Per: _____



Periodic Trends

Can the properties of an element be predicted using a periodic table?

Why?

The periodic table is often considered to be the "best friend" of chemists and chemistry students alike. It includes information about atomic masses and element symbols, but it can also be used to make predictions about atomic size, electronegativity, ionization energies, bonding, solubility, and reactivity. In this activity you will look at a few periodic trends that can help you make those predictions. Like most trends, they are not perfect, but useful just the same.

Prerequisites:

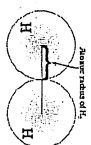
Answer the following questions using the resources above.

1. What happens to the number of valence electrons as you go down a group on the periodic table?
2. What happens to the number of valence electrons as you go from left to right across a period?
3. What happens to the number of energy levels as you go down a group on the periodic table?
4. What happens to the number of energy levels as you go from left to right across a period?

5. What happens to nuclear charge as you go from L to R across a period?

Periodic Trend Glossary:

Atomic Radius: half the distance between the nuclei of two atoms of the same element when the atoms are joined. Describes the size of the atom of an element.



Ionic Radius: describes the size of an element after it has lost or gained electrons to become an ion.

Electronegativity: the ability of an atom to attract electrons.

Ionization Energy: describes an atom's ability to lose its most loosely bound valence electrons.

Use Reference Table S to find and compare the electronegativity, ionization energy, and atomic radius values of the elements.

Atomic Radius Introduction

Period Trend:

Draw the Bohr diagrams for Lithium and Fluorine. Recall, positive charges attract negative charges. Therefore, protons will attract the electrons in the energy levels. The more protons an atom has, the stronger the pull on electrons. Try and draw the relative distance between the nucleus and energy levels with this concept in mind.

Li	F

Using table S, record the radius of Lithium and Fluorine: _____ and _____

Group Trend:

Draw the Bohr diagram for Beryllium and Magnesium.

Be	Mg

Using table S, record the radius of Beryllium and Magnesium: _____ and _____
Is this what you would expect based on your Bohr diagrams? Explain.

Set A: Data and Graph for Group 2 (The Alkaline Earth Metals):

Using Reference Table S, complete the tables below for Group 2 Alkali Earth metals. Once done, scale, plot and graph the data on the graphing grids to observe the trends of the four properties.

Group 2: Alkaline Earth Metals. List the elements in the order of increasing atomic numbers.

Atomic Number	Element Symbol	Electronegativity	Ionization Energy	Atomic Radius (pm)	Melting Point (K)

Trend in Electronegativity

Atomic Numbers

Trend in Ionization Energy

Atomic Numbers

Atomic Radius (pm)

Trend in Atomic Radius (size)

Atomic Numbers

Melting Point (K)

Trend in Melting Point

Atomic Numbers

Set B: Data and Graph for Period 2 Elements

Using Reference Table S, complete the table below for the Period 2 elements. Once done, scale, plot and graph the data on the graphing grids to observe trends of the four properties.

Period 2 Elements. List the elements in the order of increasing atomic numbers.

Atomic Number	Element Symbol	Electronegativity	Ionization Energy	Atomic Radius (pm)	Melting Point (K)

Trend in Electronegativity

Atomic Numbers

Trend in Ionization Energy

Atomic Numbers

Atomic Radius (pm)

Trend in Atomic Radius (size)

Atomic Numbers

Melting Point (K)

Trend in Melting Point

Atomic Numbers

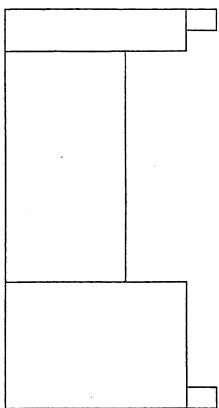
Atomic Radius

1. Define atomic radius.

2. What is the trend as you move down a group (column)? Explain your answer in terms of number of energy shells.

3. What is the trend as you move across a period (row)? Explain your answer in terms of number of protons in the nucleus.

4. On the representation of the periodic table below, draw and label 2 arrows to represent an "increasing atomic radius".



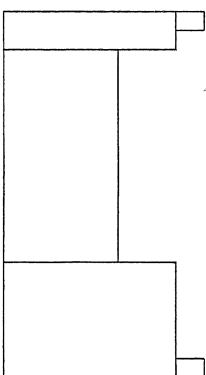
Electronegativity

1. Define electronegativity.

2. What is the trend as you move down a group (column)? Explain your answer in terms of number of energy levels (shells).

3. What is the trend as you move across a period (row)? Explain your answer in terms of number of protons on the nucleus.

4. On the representation of the periodic table below, draw and label 2 arrows to represent an "increasing electronegativity".



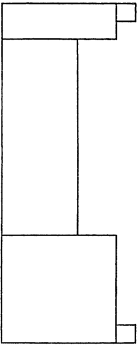
Ionization Energy

1. Use your glossary to define ionization energy.

2. What is the trend as you move down a group (column)? Explain your answer in terms of distance between valence electrons and nucleus.

3. What is the trend as you move across a period (row)? Explain your answer in terms of number of protons in the nucleus.

4. On the representation of the periodic table below, draw and label 2 arrows to represent "increasing first ionization energy".



Ionic Radius vs. Atomic Radius

1. A) When an atom loses an electron, what is its charge? ____ What do you think happens to the size of the atom?

B) Draw a diagram of a sodium atom becoming an ion.

Sodium Atom

Sodium Ion

2. A) When an atom gains an electron, what is its charge? ____ What do you think happens to the size of the atom?

B) Draw a diagram of a metal atom becoming an ion.

Fluorine Atom

Fluorine Ion

3. Give the charge for each of the ions formed by the following atoms. Your answers should include the magnitude of the charge with a positive or negative sign (i.e., +1, +2, -1, etc.). Also for each problem (A-L), state whether the atom or ion would be larger.

- | | | | | | |
|-------|------|-------|-------|-------|-------|
| A) S | B) F | C) Br | D) Sr | E) K | F) Be |
| G) Al | H) P | I) O | J) Cl | K) Ba | L) Li |

Conclusion Questions

- As atomic number increases within Group 15 on the Periodic Table, atomic radius
 - decreases, only
 - increases, only
 - decreases, then increases
 - increases, then decreases
- Which general trend is demonstrated by the Group 17 elements as they are considered in order from top to bottom on the Periodic Table?
 - a decrease in atomic radius
 - a decrease in electronegativity
 - an increase in first ionization energy
 - an increase in nonmetallic behavior

- In the ground state, each atom of an element has two valence electrons. This element has lower first ionization energy than calcium. Where is this element located on the Periodic Table?
 - Group 1, Period 4
 - Group 2, Period 5
 - Group 2, Period 3
 - Group 3, Period 4

Base your answer to the following question on the table below.

First Ionization Energy of Selected Elements

Element	Atomic Number	First Ionization Energy (kJ/mol)
lithium	3	520
sodium	11	496
potassium	19	419
rubidium	37	403
cesium	55	376

- Explain, in terms of atomic structure, why cesium has lower first ionization energy than rubidium.
- A metal, *M*, was obtained from a compound in a rock sample. Experiments have determined that the element is a member of Group 2 on the Periodic Table of the Elements. Explain why the radius of a positive ion of element *M* is smaller than the radius of an atom of element *M*.

Questions on Atomic Radius

- An atom of which element has the largest radius?
 - Fe
 - Mg
 - Si
 - Zn
- As atomic number increases within Group 15 on the Periodic Table, atomic radius
 - decreases, only
 - decreases, then increases
 - increases, only
 - increases, then decreases
- How do the atomic radius and metallic properties of Na compare to the atomic radius and metallic properties of P?
 - Sodium has a larger atomic radius and is more metallic.
 - Sodium has a larger atomic radius and is less metallic.
 - Sodium has a smaller atomic radius and is more metallic.
 - Sodium has a smaller atomic radius and is less metallic.
- Which list of elements from Group 2 is arranged in order of increasing radius?
 - Be, Mg, Ca
 - Ca, Mg, Be
 - Ba, Ra, Sr
 - Sr, Ra, Ba
- The data table below shows elements Xx, Yy, and Zz from the same group on the Periodic Table.

Element	Atomic Mass (atomic mass unit)	Atomic Radius (pm)
Xx	69.7	111
Yy	114.8	Y
Zz	201.4	171

What is the most likely atomic radius of element Yy?

 - 103 pm
 - 127 pm
 - 166 pm
 - 185 pm

As the elements in Period 2 are considered in succession from left to right, there is a decrease in atomic radius with increasing atomic number. This may best be explained by the fact that the

 - number of protons increases, the number of shells of electrons remains the same
 - number of protons increases, and the number of shells of electrons increases
 - number of protons decreases, the number of shells of electrons remains the same
 - number of protons decreases, and the number of shells of electrons increases
- Which of the following electron configurations represents the element with the smallest radius?
 - 2-4
 - 2-5
 - 2-6
 - 2-7
- Which electron configuration represents the atom with the largest atomic radius?
 - 1
 - 2-1
 - 2-2
 - 2-3
- As the elements of Group 16 are considered in order from top to bottom, the covalent radius of each successive element increases. This increase is primarily due to an increase in
 - atomic number
 - mass number
 - the number of protons occupying the nucleus
 - the number of occupied electron shells
- An ion of which element has a larger radius than an atom of the same element?
 - aluminum
 - chlorine
 - magnesium
 - sodium
- An atom with the electron configuration 2-8-2 would most likely
 - decrease in size as it forms a positive ion
 - increase in size as it forms a positive ion
 - decrease in size as it forms a negative ion
 - increase in size as it forms a negative ion
- The radius of a calcium ion is smaller than the radius of a calcium atom because the calcium ion contains the same nuclear charge and
 - fewer protons
 - fewer electrons
 - more protons
 - more electrons
- A chloride ion differs from a chlorine atom in that the chloride ion has
 - more protons
 - a larger radius
 - fewer protons
 - a smaller radius
- How does the size of a barium ion compare to the size of a barium atom?
 - The ion is smaller because it has fewer electrons.
 - The ion is smaller because it has more electrons.
 - The ion is larger because it has fewer electrons.
 - The ion is larger because it has more electrons.

QUESTIONS ON ELECTRONEGATIVITY

- Which general trend is found in Period 3 as the elements are considered in order of increasing atomic number?
 - increasing atomic radius
 - increasing electronegativity
 - decreasing atomic mass
 - decreasing first ionization energy
- Which statement describes the general trends in electronegativity and metallic properties as the elements in Period 2 are considered in order of increasing atomic number?
 - Both electronegativity and metallic properties decrease.
 - Electronegativity decreases and metallic properties increase.
 - Electronegativity increases and metallic properties decrease.
 - Both electronegativity and metallic properties increase.
- Which atom has the *weakest* attraction for electrons in a chemical bond?
 - boron
 - calcium
 - fluorine
 - nitrogen
- Which general trend is demonstrated by the Group 17 elements as they are considered in order from top to bottom on the Periodic Table?
 - a decrease in atomic radius
 - an increase in first ionization energy
 - a decrease in electronegativity
 - an increase in nonmetallic behavior
- Which properties are most common in nonmetals?
 - low ionization energy and low electronegativity
 - low ionization energy and high electronegativity
 - high ionization energy and low electronegativity
 - high ionization energy and high electronegativity
- Which element in Period 2 has the greatest tendency to form a negative ion?
 - Lithium
 - carbon
 - neon
 - fluorine
- Elements that readily gain electrons tend to have
 - high ionization energy and high electronegativity
 - high ionization energy and low electronegativity
 - low ionization energy and low electronegativity
 - low ionization energy and high electronegativity
- Element *M* has an electronegativity of less than 1.2 and reacts with bromine to form the compound MBr_2 . Element *M* could be
 - Al
 - Na
 - Ca
 - K
- The Group 17 element with the highest electronegativity is
 - Fluorine
 - chlorine
 - bromine
 - iodine
- The ability of carbon to attract electrons is
 - greater than nitrogen, but less than oxygen
 - less than nitrogen, but greater than oxygen
 - greater than that of nitrogen and oxygen
 - less than that of nitrogen and oxygen

QUESTIONS ON IONIZATION ENERGY

- Which general trend is found in Period 2 on the Periodic Table as the elements are considered in order of increasing atomic number?
 - Decreasing atomic mass
 - increasing ionization energy
 - increasing atomic radius
 - decreasing atomic mass
- As the elements of Group 1 on the Periodic Table are considered in order of increasing atomic radius, the ionization energy of each successive element generally
 - decreases
 - remains the same
 - increases
 - decreases
- The amount of energy required to remove the outermost electron from a gaseous atom in the ground state is known as
 - first ionization energy
 - activation energy
 - ionization energy
 - electron affinity
- Which atom in the ground state requires the *least* amount of energy to remove its valence electron?
 - lithium atom
 - potassium atom
 - rubidium atom
 - sodium atom
- Which element requires the *least* amount of energy to remove the most loosely held electron from its atom?
 - bromine
 - calcium
 - sodium
 - silver
- Samples of four Group 15 elements, antimony, arsenic, bismuth, and phosphorus, are in the gaseous phase. An atom in the ground state of which element requires the *least* amount of energy to remove its most loosely held electron?
 - As
 - Bi
 - P
 - Sb

- In the ground state, each atom of an element has two valence electrons. This element has a lower first ionization energy than calcium. Where is this element located on the Periodic Table?
 - Group 1, Period 4
 - Group 2, Period 5
 - Group 2, Period 3
 - Group 3, Period 4
- Which electron configuration represents an element with the highest first ionization energy?
 - $2s^1$
 - $2s^2$
 - $2s^2 2p^1$
 - $2s^2 2p^2$
- What does the second ionization energy refer to?
 - Removing two electrons at once
 - Removing the second electron from the valence
 - Adding an electron back to the ion
 - Removing the second electron from the ion
- Which element can have the following ionization energies:

First	Second	Third	Fourth
250	500	2500	2800

 - K
 - Mg
 - O
 - F
- Which element can have the following ionization energies:

First	Second	Third	Fourth
100	700	900	1000

 - K
 - Mg
 - O
 - F
- Low ionization energies are most characteristic of atoms that are
 - metals
 - metalloids
 - nonmetals
 - noble gases