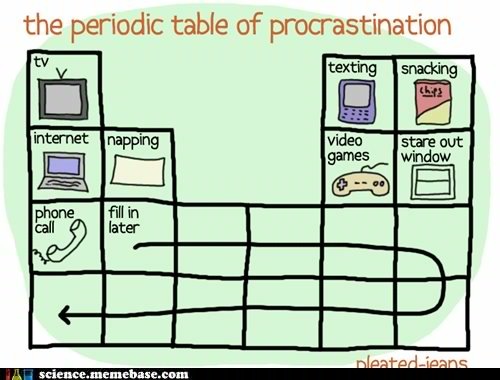
**Key Ideas:**

* The placement or location of elements on the Periodic Table gives an indication of physical and chemical properties of that element. The elements on the Periodic Table are arranged in order of increasing atomic number. (3.1y)
* Elements can be classified by their properties and located on the Periodic Table as metals, nonmetals, metalloids (B, Si, Ge, As, Sb, Te), and noble gases. (3.1v)
* Elements can be differentiated by their physical properties. Physical properties of substances, such as density, conductivity, malleability, solubility, and hardness, differ among elements. (3.1w)
* Elements can be differentiated by chemical properties. Chemical properties describe how an element behaves during a chemical reaction. (3.1x)
* Some elements exist in two or more forms in the same phase. These forms differ in their molecular or crystal structure, and hence in their properties. (5.2f)
* For Groups 1, 2, and 13-18 on the Periodic Table, elements within the same group have the same number of valence electrons (helium is an exception) and therefore similar chemical properties. (3.1z)
* The succession of elements within the same group demonstrates characteristic trends: differences in atomic radius, ionic radius, electronegativity, first ionization energy, metallic/nonmetallic properties. (3.1aa)
* The succession of elements across the same period demonstrates characteristic trends: differences in atomic radius, ionic radius, electronegativity, first ionization energy, metallic/nonmetallic properties. (3.1bb)

**Activity**: Color Coding the Periodic Table

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. A small group of elements, whose members touch the zigzag line, are called metalloids because they have both metallic and nonmetallic properties. Identify the zig zag line and make it more bold using a black crayon.

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. 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) Outline Hydrogen in red.

Group 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) Color the alkali metals in red.

Group 2: Alkaline-earth Metals – Slightly less reactive than alkali metals. They are silver colored and more dense than alkali metals. (2 outer level electrons) Color the alkaline earth metals in orange.

Groups 3 – 12: 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) Color the transition metals in pink.

Lanthanides and Actinides: 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. Color the lanthanides and actinides brown.

Group 13: 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) Color group 13 yellow.

Group 14: Carbon Group – Contains on nonmetal, two metalloids, and two metals. Varied reactivity. (4 outer level electrons) Color group 14 light green.

Group 15: Nitrogen Group – Contains two nonmetals, two metalloids, and one metal. Varied reactivity. (5 outer level electrons) Color group 15 dark green.

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

Group 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) Color group 17 dark blue.

Group 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) Color group 18 Purple.

**Analysis**:

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

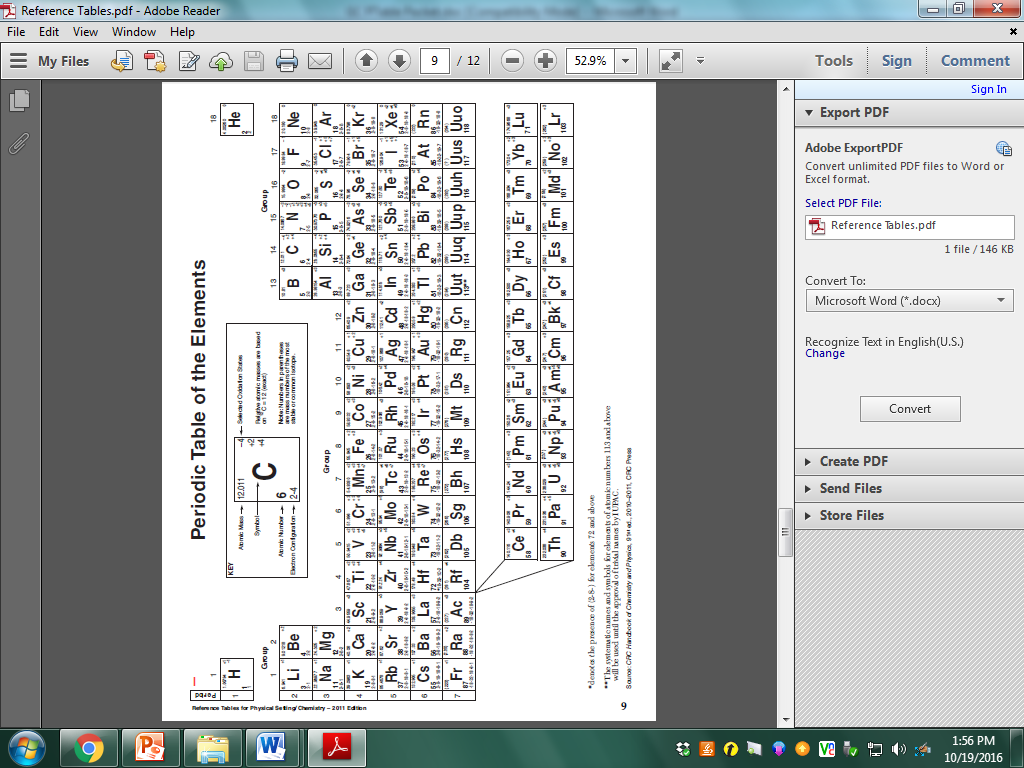
8. Elements in groups 3 through 12 have many useful properties and are called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

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 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.



**Periods and Groups Introduction**

**Look at the periodic table of elements.**

1. Periods represent the (vertical/horizontal) rows on the table.
2. Draw Bohr diagrams for Carbon, Boron and Oxygen, all in period 2.
3. Elements in the same period have the same number of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
4. Groups represent the (vertical/horizontal) columns on the table.
5. Draw Bohr diagrams for Lithium, Sodium, and Potassium, all in group 1.
6. Elements in the same group have the same number of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

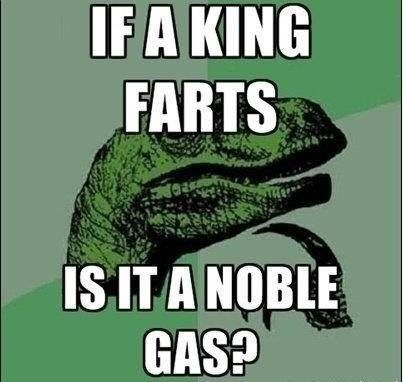
**RULES**: Group 1 are known as Alkali Metals. Group 2 are Alkaline earth metals. Groups 3-12 are Transition metals. Group 17 are Halogens. Group 18 are Noble gases. All other groups do not have names.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Name** | **Symbol** | **Period** | **# Energy Levels** | **Group** | **# Valence Electrons** | **Group Name** | **Lewis Diagram** |
| Sodium |  |  |  |  |  |  |  |
|  | S |  |  |  |  |  |  |
|  | Ne |  |  |  |  |  |  |
|  |  | 1 |  |  |  | Noble Gases |  |
|  |  | 2 |  | 2 |  |  |  |
|  |  | 2 |  |  |  | Alkali Metals |  |
|  |  |  | 4 | 1 |  |  |  |
|  |  |  | 4 |  | 7 |  |  |
|  |  |  | 4 |  |  | Alkaline Earth  Metals |  |
|  |  | 2 |  |  |  | Halogens |  |
|  |  |  | 3 |  | 8 |  |  |

**Periods and Groups Summary**

**Look at the periodic table of elements.**

1. How many periods are on the periodic table of elements?
2. Write out electron configurations for any three elements in period 3.
3. What do elements in the same period have in common?
4. How many groups are on the periodic table of elements?
5. Write out Lewis dot diagrams for any three elements in group 18.
6. Write out the most probable charges of elements in group:
   1. One\_\_\_ b. Two\_\_\_ c. Seventeen\_\_\_\_ d. Eighteen\_\_\_
7. What do elements in the same group have in common?
8. Do elements in the same period have more or less in common than elements in the same group?

****

**Metals, Nonmetals, and Metalloids Introduction**

1. Draw the Bohr diagrams for Neon and Helium and explain why they do not bond:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Draw the Bohr diagrams for Sodium and Calcium and explain why **metals lose electrons**:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Draw the Bohr diagrams for Fluorine and Sulfur and explain why **nonmetals gain electrons**:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Draw the Bohr diagrams for Silicon and germanium and explain why they are **metalloids**:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Metals, Nonmetals, and Metalloids Activity**

Directions: For each element, write observations and given details and determine if they are metals, nonmetals, or metalloids (semimetals). Then complete the rest of the table.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Observations/Details** | **M, NM, or SM** | **Element** | **Period** | **Group** |
| 1 |  |  |  |  |  |
| 2 |  |  |  |  |  |
| 3 |  |  |  |  |  |
| 4 |  |  |  |  |  |
| 5 |  |  |  |  |  |
| 6 |  |  |  |  |  |
| 7 |  |  |  |  |  |
| 8 |  |  |  |  |  |
| 9 |  |  |  |  |  |
| 10 |  |  |  |  |  |
| 11 |  |  |  |  |  |
| 12 |  |  |  |  |  |
| 13 |  |  |  |  |  |
| 14 |  |  |  |  |  |

1. Which three groups of the Periodic Table contain the most elements classified as metalloids (semimetals)?

A) 1, 2, and 13 B) 2, 13, and 14

C) 14, 15, and 16 D) 16, 17, and 18

1. Which elements have the most similar chemical properties?
   1. K and Na B) K and Cl

C) K and Ca D) K and S

1. The metalloids that are included in Group 15 are antimony and
   1. N B) P C) As D) Bi
2. Which element is a member of the halogen family?
   1. K B) B C) I D) S
3. Which represents the electron configuration of a metalloid?

A) 2-3 B) 2-5 C) 2-8-5 D) 2-8-6

1. An atom of an element contains 20 protons, 20 neutrons, and 20 electrons. This element is in Group

A) 1 B) 2 C) 4 D) 18

7. Which sequence of atomic numbers represents elements which have similar chemical properties?

A) 19, 23, 30, 36 B) 9, 16, 33, 50

C) 3, 12, 21, 40 D) 4, 20, 38, 88

1. Alkali metals, alkaline earth metals, and halogens are elements found respectively in Groups

A) 1, 2, and 18 B) 2, 13, and 17

C) 1, 2, and 14 D) 1, 2, and 17

1. Which group contains elements composed of diatomic molecules at STP?

A) 11 B) 2 C) 7 D) 17

1. On the Periodic Table, an element classified as a semimetal (metalloid) can be found in
   1. Period 6, Group 15 B) Period 2, Group 14

C) Period 3, Group 16 D) Period 4, Group 15

1. Atoms of metallic elements tend to
   1. gain electrons and form negative ions
   2. gain electrons and form positive ions
   3. lose electrons and form negative ions
   4. lose electrons and form positive ions
2. Which element is considered malleable?
   1. gold B) hydrogen

C) sulfur D) radon

1. Which element is malleable and conducts electricity?
   1. iron B) iodine

C) sulfur D) phosphorus

1. Which element is malleable and ductile?
   1. S B) Si C) Ge D) Au
2. Which element is brittle and does *not* conduct heat or electricity?
   1. S(s) B) Mg(s) C) Al(s) D) K(s)
3. Which element is an active nonmetal?
   1. Neon B) oxygen C) zinc D) chromium
4. Which characteristics describe most solid nonmetals?
   1. They are malleable and have metallic luster.
   2. They are malleable and lack metallic luster.
   3. They are brittle and have metallic luster.
   4. They are brittle and lack metallic luster.
5. An atom in the ground state has a stable valence electron configuration. This atom could be an atom of
   1. Al B) Cl C) Na D) Ne
6. Which element at STP exists as monatomic molecules?
   1. N B) O C) Cl D) Ne
7. Which element is a metalloid?
   1. Al B) Ar C) As D) Au
8. The element arsenic (As) has the properties of
   1. metals, only
   2. nonmetals, only
   3. both metals and nonmetals
   4. neither metals nor nonmetals
9. Which element is *not* a metalloid?
   1. arsenic B) boron

C) silicon D) sulfur

1. An atom in the ground state contains a total of 5 electrons, 5 protons, and 5 neutrons. Which Lewis electron-dot diagram represents this atom?

A)  B)  C)  D) 

1. Magnesium and calcium have similar chemical properties because a magnesium atom and a calcium atom have the same
   1. atomic number
   2. mass number
   3. total number of electron shells
   4. total number of valence electrons
2. Which compound forms a green aqueous solution?
   1. RbCl B) CaCl2 C) NiCl2 D) MgCl2

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Metal** | **Metalloid** | **Nonmetal** | **Alkali**  **Metal** | **Alkaline**  **Earth**  **Metal** | **Transition**  **metal** | **Halogen** | **Noble**  **gas** | **Monatomic** | **Diatomic** |
| **Sb** |  |  |  |  |  |  |  |  |  |  |
| **Sr** |  |  |  |  |  |  |  |  |  |  |
| **Rn** |  |  |  |  |  |  |  |  |  |  |
| **P** |  |  |  |  |  |  |  |  |  |  |
| **Pt** |  |  |  |  |  |  |  |  |  |  |
| **Cs** |  |  |  |  |  |  |  |  |  |  |
| **S** |  |  |  |  |  |  |  |  |  |  |
| **Fe** |  |  |  |  |  |  |  |  |  |  |
| **Br** |  |  |  |  |  |  |  |  |  |  |
| **Ar** |  |  |  |  |  |  |  |  |  |  |
| **H** |  |  |  |  |  |  |  |  |  |  |
| **Si** |  |  |  |  |  |  |  |  |  |  |
| **B** |  |  |  |  |  |  |  |  |  |  |
| **F** |  |  |  |  |  |  |  |  |  |  |
| **He** |  |  |  |  |  |  |  |  |  |  |
| **Se** |  |  |  |  |  |  |  |  |  |  |
| **Zn** |  |  |  |  |  |  |  |  |  |  |
| **Ra** |  |  |  |  |  |  |  |  |  |  |

1. Put a check in each box that correctly describes the element given.
2. Write in the space, “alkali metals”, “alkaline earth metals”, “transition metals”, “halogens”, or “noble gases” to indicate which group each statement is describing.

|  |  |  |
| --- | --- | --- |
| a. |  | Colored solutions |
| b. |  | Full valence shell |
| c. |  | Most active metals |
| d. |  | Most active nonmetals |
| e. |  | Monatomic gases |
| f. |  | Diatomic elements |
| g. |  | Stable and unreactive |
| h. |  | 7 valence electrons |
| i. |  | 2 valence electrons |
| j. |  | Form ions with a +1 charge |

**Atomic Radius Introduction**

**Period Trend:**

1. Draw the Bohr diagrams for Lithium and Fluorine. Create a nucleus with a *diameter* of 2.0 cm. Create a first energy level with a *radius* of 2.0 cm (measure from center of nucleus. The second energy level will have a *radius* close to 4.0cm. **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.** Draw the second energy level in considering these statements.

F

Li

1. Using table S, record the radius of Lithium and Fluorine: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
2. Provide a rule that explains the trend of Atomic Radius in a period with respect to the number of protons, electrons, and energy levels in the atom.

**Group Trend:**

1. Draw the Bohr diagram for Beryllium and Magnesium. Create a nucleus with a *diameter* of 2.0 cm. Create a first energy level with a *radius* of 2.0 cm (measure from center of nucleus). Each additional energy level will add 1.0cm to the *radius*.

Mg

Be

1. Using table S, record the radius of Beryllium and Magnesium: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
2. Provide a rule to explain the trend of Atomic radius in a group with respect to the number of protons, electrons, and energy levels in the atom.

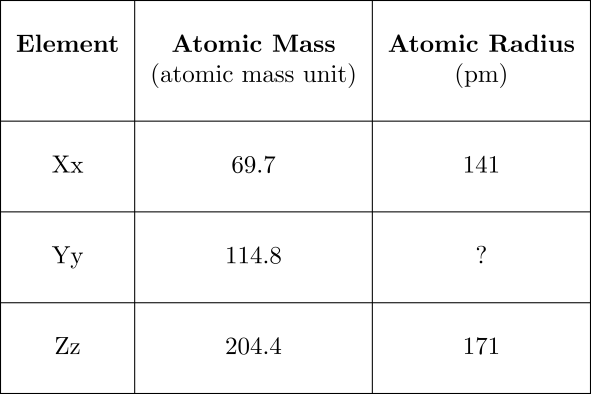
**Regents Questions on Atomic Radius**

1. An atom of which element has the largest radius?
   1. Fe b. Mg c. Si d. Zn
2. As atomic number increases within Group 15 on the Periodic Table, atomic radius
   1. decreases, only
   2. decreases, then increases
   3. increases, only
   4. increases, then decreases
3. How do the atomic radius and metallic properties of Na compare to the atomic radius and metallic properties of P?
   1. Sodium has a larger atomic radius and is more metallic.
   2. Sodium has a larger atomic radius and is less metallic.
   3. Sodium has a smaller atomic radius and is more metallic.
   4. Sodium has a smaller atomic radius and is less metallic.
4. Which list of elements from Group 2 is arranged in order of increasing radius?

a. Be, Mg, Ca b. Ca, Mg, Be

c. Ba, Ra, Sr d. Sr, Ra, Ba

1. The data table below shows elements *Xx, Yy,* and *Zz* from the same group on the Periodic Table.



What is the most likely atomic radius of element *Yy*?

a. 103 pm b. 127 pm c. 166 pm d. 185 pm

1. 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
2. number of protons increases, the number of shells of electrons remains the same
3. number of protons increases, and the number of shells of electrons increases
4. number of protons decreases, the number of shells of electrons remains the same

Memorize:

1. number of protons decreases, and the number of shells of electrons increases
2. Which of the following electron configurations represents the element with the smallest radius?
3. 2-4 b. 2-5 c. 2-6 d. 2-7
4. Which electron configuration represents the atom with the largest atomic radius?
5. 1 b. 2-1 c. 2-2 d. 2-3
6. 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
7. atomic number
8. mass number
9. the number of protons occupying the nucleus
10. the number of occupied electron shells
11. An ion of which element has a larger radius than an atom of the same element?
12. aluminum c. chlorine
13. Magnesium d. sodium
14. An atom with the electron configuration 2-8-2 would most likely
15. decrease in size as it forms a positive ion
16. increase in size as it forms a positive ion
17. decrease in size as it forms a negative ion
18. increase in size as it forms a negative ion
19. 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
20. fewer protons c. more protons
21. fewer electrons d. more electrons
22. A chloride ion *differs* from a chlorine atom in that the chloride ion has
23. more protons c. fewer protons
24. a larger radius d. a smaller radius
25. How does the size of a barium ion compare to the size of a barium atom?
26. The ion is smaller because it has fewer electrons.
27. The ion is smaller because it has more electrons.
28. The ion is larger because it has fewer electrons.
29. The ion is larger because it has more electrons.

**Ionization Energy Introduction**

**Period Trend:**

1. Draw the Bohr diagrams of Lithium and Fluorine using the key:

Protons

Neutrons

Electrons

1. On your diagrams above, use an arrow to show the attraction of protons to electrons in the structure.

For example:

1. Which atom, lithium or fluorine, feels the most pull on its valence shell? Explain your answer.

Ionization Energy is defined as the energy needed to

remove the most loosely bound valence electron from an atom.

1. For which atom, Lithium or fluorine, is it harder to remove its most loosely bound valence electron? Explain your answer.
2. Using table S, record the Ionization energies of Lithium and Fluorine: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
3. Describe the trend of ionization energies with in a period in terms of protons, electrons, and energy levels.

**Group Trend:**

1. Draw the Bohr diagrams of Beryllium and Magnesium using the key above.
2. On your diagrams above, use an arrow to show the attraction of protons to electrons in the structure.

For example: Use the same size arrows to denote that the pull of each proton is the same amount of energy.

1. Which atom, beryllium or magnesium, feels the most pull on its valence shell? Explain your answer.
2. For which atom, beryllium or magnesium, is it harder to remove its most loosely bound valence electron? Explain your answer.
3. Using table S, record the Ionization Energies of Beryllium and Magnesium: \_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_.
4. Describe the trend of ionization energies with in a group in terms of protons, electrons, and energy levels.

**Regents Questions on Ionization Energy**

1. Which general trend is found in Period 2 on the Periodic Table as the elements are considered in order of increasing atomic number?
   1. Decreasing atomic mass
   2. increasing ionization energy
   3. increasing atomic radius
2. 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
   1. decreases c. increases
   2. remains the same
3. The amount of energy required to remove the outermost electron from a gaseous atom in the ground state is known as
   1. first ionization energy c. activation energy
   2. conductivity d. electronegativity
4. Which atom in the ground state requires the *least amount of energy to remove its valence electron?*
   1. lithium atom c. rubidium atom
   2. potassium atom d. sodium atom
5. Which element requires the *least* amount of energy to remove the most loosely held electron from its atom?
   1. bromine c. sodium
   2. calcium d. silver
6. 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?
   1. As b. Bi c. P d. Sb
7. 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?
   1. Group 1, Period 4 c. Group 2, Period 5
   2. Group 2, Period 3 d. Group 3, Period4
8. Which electron configuration represents an element with the highest first ionization energy?
   1. 2-1 b. 2-2 c. 2-8-1 d. 2-8-2
9. What does the second ionization energy refer to?
   1. Removing two electrons at once
   2. Removing the second electron from the valence
   3. Adding an electron back to the ion
10. Which element can have the following ionization energies:

|  |  |  |  |
| --- | --- | --- | --- |
| First | Second | Third | Fourth |
| 250 | 500 | 2500 | 2800 |

* 1. K b. Mg c. O d. F

1. Which element can have the following ionization

energies:

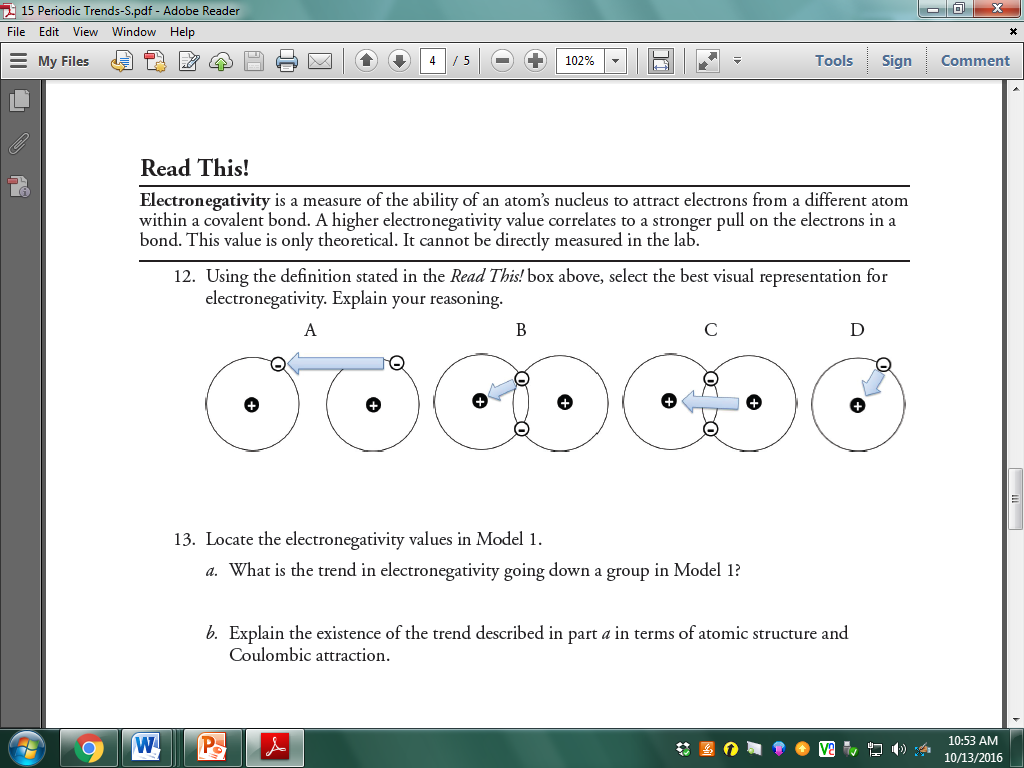
|  |  |  |  |
| --- | --- | --- | --- |
| First | Second | Third | Fourth |
| 100 | 700 | 900 | 1000 |

* 1. K b. Mg c. O d. F

1. Low ionization energies are most characteristic of atoms that are
   1. metals c. nonmetals
   2. metalloids d. noble gases

Memorize:

**Electronegativity Introduction**

**Period Trend:**

1.

1. What particle in the nucleus is responsible for attracting the electrons of another atom as described above?
2. Finish the statement: Fluorine has (more/less) protons than lithium and a (larger/smaller) electronegativity value because fluorine’s nucleus has a (stronger/weaker) pull on new electrons than lithium.
3. Using table S, record the electronegativity values of Lithium and Fluorine: \_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_.
4. Describe the trend of electronegativity with in a period in terms of protons, electrons and energy levels.

**Group Trend:**

1. Magnesium has more protons than beryllium but a weaker pull on electrons. Draw Be and Mg Bohr diagrams with arrows to denote the pull of protons on electrons of a new atom. Use the diagrams to determine what other factor might make Magnesium’s nucleus not pull as strong.
2. Using table S, record the electronegativity values of Beryllium and Magnesium: \_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_
3. Describe the trend of electronegativity with in a group in terms of protons, electrons and energy levels.
4. Describe why fluorine would have the highest electronegativity of all elements in terms of protons, electrons and energy levels.
5. Explain a possible reason why noble gases have no published electronegativity values based on your knowledge of noble gas properties.

**Regents Questions on Electronegativity**

1. Which general trend is found in Period 3 as the elements are considered in order of increasing atomic number?

A) increasing atomic radius

B) increasing electronegativity

C) decreasing atomic mass

D) decreasing first ionization energy

1. 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?
   1. Both electronegativity and metallic properties decrease.
   2. Electronegativity decreases and metallic properties increase.
   3. Electronegativity increases and metallic properties decrease.
2. Which atom has the *weakest* attraction for electrons in a chemical bond?

A) boron B) calcium C) fluorine D) nitrogen

1. Which general trend is demonstrated by the Group 17 elements as they are considered in order from top to bottom on the Periodic Table?
   1. a decrease in atomic radius
   2. an increase in first ionization energy
   3. a decrease in electronegativity
   4. an increase in nonmetallic behavior
2. Which properties are most common in nonmetals?
   1. low ionization energy and low electronegativity
   2. low ionization energy and high electronegativity
   3. high ionization energy and low electronegativity
   4. high ionization energy and high electronegativity
3. Which element in Period 2 has the greatest tendency to form a negative ion?
   1. Lithium b. carbon c. neon d. fluorine
4. Elements that readily gain electrons tend to have
   1. high ionization energy and high electronegativity
   2. high ionization energy and low electronegativity
   3. low ionization energy and low electronegativity
   4. low ionization energy and high electronegativity
5. Element *M* has an electronegativity of less than 1.2 and reacts with bromine to form the compound *M*Br2. Element *M* could be
   1. Al b. Na c. Ca d. K
6. The Group 17 element with the highest electronegativity is
   1. Fluorine b. chlorine c. bromine d. iodine
7. The ability of carbon to attract electrons is
   1. greater than nitrogen, but less than oxygen
   2. less than nitrogen, but greater than oxygen
   3. greater than that of nitrogen and oxygen
   4. less than that of nitrogen and oxygen

Memorize:

**Trends Review**

1. Write in the space, “metals”, “metalloids”, or “nonmetals” to indicate which type of element.

|  |  |  |
| --- | --- | --- |
|  |  | Located on the left side of the P.T. |
| b. |  | Located on the right side of the P.T. |
| c. |  | Solids are brittle |
| d. |  | Majority of the elements |
| e. |  | Gain electrons to form negative ions |
| f. |  | Located along the “staircase” |
| g. |  | Have luster |
| h. |  | Malleable |
| i. |  | Lose electrons to form positive ions |
| j. |  | Ductile |
| k. |  | Excellent conductors of heat & electricity |
| l. |  | Poor electrical & heat conductors |
| m. |  | Low electronegativity values |
| n. |  | Low ionization energy |
| o. |  | High ionization energy |
| p. |  | High electronegativity values |
| q. |  | Ions are larger than their atoms |
| r. |  | Ions are smaller than their atoms |

2. Use Table S to fill in the names and states of each element below. Check all the boxes which describe the element.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Name** | **Physical Properties** | | | | | **Chemical Properties** | | | | | |
| **State at STP**  **(s, l, or g)** | **Brittle** | **Malleable**  **/ductile** | **Conductor** | | **Ionization**  **energy** | | **Electro-**  **negativity** | | **Electrons** | |
| Good | Poor | Low | High | Low | High | Lose | Gain |
| C |  |  |  |  |  |  |  |  |  |  |  |  |
| Ag |  |  |  |  |  |  |  |  |  |  |  |  |
| Mg |  |  |  |  |  |  |  |  |  |  |  |  |
| I |  |  |  |  |  |  |  |  |  |  |  |  |
| S |  |  |  |  |  |  |  |  |  |  |  |  |
| Au |  |  |  |  |  |  |  |  |  |  |  |  |
| Fe |  |  |  |  |  |  |  |  |  |  |  |  |
| Br |  |  |  |  |  |  |  |  |  |  |  |  |
| Ar |  |  |  |  |  |  |  |  |  |  |  |  |
| H |  |  |  |  |  |  |  |  |  |  |  |  |
| Hg |  |  |  |  |  |  |  |  |  |  |  |  |

**Unit 4 Periodic Trends: Chemistry Review**

**THE PERIODIC LAW**

The **Periodic Law** states that when elements are arranged in order of increasing atomic number, repetitious trends can be seen. **Mendeleev’s** periodic table was arranged in order of increasing atomic mass. He then arranged columns in order to have elements with similar properties align in columns. The **modern** table is arranged by atomic number.

a. What subatomic particle decides the order of the modern periodic table? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

b. Explain how Mendeleev’s table is only slightly different than the modern table. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**METALS, NONMETALS, AND METALLOIDS**

**Metals** are elements on the left side of the staircase on the periodic table. They have 1-2 valence electrons, which they tend to lose to form cations. Metals are **lustrous**, **malleable**, **ductile**, and good conductors of heat and electricity.

a. Define lustrous. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

b. Define malleable. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

c. Define ductile. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

d. Circle the metal: H P Cu S

**Nonmetals** are elements on the right side of the staircase on the periodic table. They have 4-8 valence electrons, which they tend to gain to form anions and fill their octet. Nonmetals are dull, brittle, and poor conductors of heat and electricity.

a. Circle the nonmetal: C Mg Na Au

b. Why is hydrogen considered to be a nonmetal? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Metalloids** are elements that touch the staircase on the periodic table. They have properties of both metals and nonmetals.

a. Most elements on the periodic table can be classified as metal, nonmetal, or metalloid?

b. Circle the metalloid: S Si Se Sr

c. Circle the element that is lustrous: Na N Rn Ne

d. Circle the element that is malleable: Mg C Ar H

e. Circle the element that is dull: S Sc Sr Sn

f. Circle the best conductor: C Cl Cu He

g. Circle the element that has properties of both metals and nonmetals: Ge Ga

**GROUPS AND PERIODS**

**Periods** are the horizontal rows on the periodic table. Elements in the same period have the same number of electron levels in the Bohr diagram.

a. Draw Bohr diagrams of Na, Si, Li and C and show how you can tell which are in the same period.

b. How many energy levels will an atom in the second period have? \_\_\_\_\_\_\_\_ Third period? \_\_\_\_\_\_\_\_\_\_

**Groups** (or families) are the vertical columns on the periodic table. Elements in the same group have the same number of valence electrons and often have similar properties.

a. How many valence electrons do the following atoms have?

Na: \_\_\_ Mg: \_\_\_ Al: \_\_\_ Si: \_\_\_ P: \_\_\_ S: \_\_\_ Cl: \_\_\_

b. Which two have the same number of valence electrons? Ca S Mg

Group 1 elements are the **Alkali Metals**, which have 1 valence electron and are very reactive (explode in water). Group 2 elements are the **Alkaline Earth Metals**, which have 2 valence electrons and are still very reactive (not as much as alkali). Groups 3-12 are the **Transition Metals**, which form colored compounds and solutions. Group 17 elements are the **Halogens**, which have 7 valence electrons and are the most reactive nonmetals. Group 18 are the **Noble Gases**, which have 8 valence electrons and are not reactive.

a. Why are the noble gases not reactive? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

b. Which element may be blue in solutions? C Cu Ca Cl

c. Which element is a halogen? C Cu Ca Cl

d. Which element is an alkaline earth metal? C Cu Ca Cl

e. Which element is a noble gas? H F Cs Rn

f. Which element is the most reactive metal? H F Cs Rn

g. Which element is the most reactive nonmetal? H F Cs Rn

**ATOMIC RADIUS**

The **atomic radius** is the size of an atom. You can look up the atomic radius on Table S of the reference tables.

a. Record the atomic radius of: Li \_\_\_\_\_\_\_\_ Be \_\_\_\_\_\_\_\_ B \_\_\_\_\_\_\_\_ C \_\_\_\_\_\_\_\_

N \_\_\_\_\_\_\_\_ O \_\_\_\_\_\_\_\_ F \_\_\_\_\_\_\_\_ Ne \_\_\_\_\_\_\_\_

b. As you go across a period the atomic radius \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ because \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

c. Record the atomic radius of: Na \_\_\_\_\_\_\_\_ Li \_\_\_\_\_\_\_\_ K \_\_\_\_\_\_\_\_ Rb \_\_\_\_\_\_\_\_ Cs \_\_\_\_\_\_\_\_

d. As you go down a group the atomic radius \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ because \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

e. Which element is the largest? \_\_\_\_\_\_\_\_\_\_\_\_ The smallest? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**ELECTRONEGATIVITY**

The **electronegativity** of an atom is its ability to gain an electron. You can look up the electronegativity on Table S of the reference tables.

a. Record the electronegativity of: Li \_\_\_\_\_\_\_\_ Be \_\_\_\_\_\_\_\_ B \_\_\_\_\_\_\_\_ C \_\_\_\_\_\_\_\_

N \_\_\_\_\_\_\_\_ O \_\_\_\_\_\_\_\_ F \_\_\_\_\_\_\_\_ Ne \_\_\_\_\_\_\_\_

b. As you go across a period the electronegativity \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ because \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

c. Record the electronegativity of: Na \_\_\_\_\_\_\_\_ Li \_\_\_\_\_\_\_\_ K \_\_\_\_\_\_\_\_ Rb \_\_\_\_\_\_\_\_ Cs \_\_\_\_\_\_\_\_

d. As you go down a group the electronegativity \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ because \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

e. Why don’t noble gases have electronegativity values? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

f. Which element has the highest electronegativity? \_\_\_\_\_\_\_\_\_\_\_\_

**IONIZATION ENERGY**

The last level contains **valence** electrons that can be lost or gained to form ions involved in bonding. **Cations** are positive ions that have lost electrons, therefore having more positive protons than negative electrons. **Anions** are negative ions that have gained electrons and then have fewer protons than electrons.

a. How many valence electrons does Sodium have? \_\_\_\_\_\_\_\_

b. How many valence electrons does fluorine have? \_\_\_\_\_\_\_\_

c. If an atom has 8 protons and 10 electrons, what is the charge? \_\_\_\_\_\_\_ What type of ion is it? \_\_\_\_\_\_\_

d. If an atom has 12 protons and 10 electrons, what is the charge? \_\_\_\_\_\_ What type of ion is it? \_\_\_\_\_\_\_

The **ionization energy** of an atom is how much energy is required to remove an electron from the valence. You can look up the ionization energies on Table S of the reference tables.

a. Record the ionization energies of: Li \_\_\_\_\_\_\_\_ Be \_\_\_\_\_\_\_\_ B \_\_\_\_\_\_\_\_ C \_\_\_\_\_\_\_\_

N \_\_\_\_\_\_\_\_ O \_\_\_\_\_\_\_\_ F \_\_\_\_\_\_\_\_ Ne \_\_\_\_\_\_\_\_

b. As you go across a period the ionization energies \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ because \_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

c. Record the ionization energies of: Na \_\_\_\_\_\_\_\_ Li \_\_\_\_\_\_\_\_ K \_\_\_\_\_\_\_\_ Rb \_\_\_\_\_\_\_\_ Cs \_\_\_\_\_\_\_\_

d. As you go down a group the ionization energies \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ because \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

e. Which element has the highest ionization energy? \_\_\_\_\_\_\_\_\_\_\_\_ The lowest? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Key Idea Question** | **Justify your answer**  **with an explanation or calculation.** | **Confidence Level**  **None Moderate Fully**  http://www.mentisology.org/wp-content/uploads/2015/07/scale-1-10.jpg |
| 1 | Which element is in period 3, group 2?   1. Be c. Mg 2. B d. Al |  | Pre-discussion:  Post discussion: |
| 2 | Which element has the strongest attraction for electrons?   1. F c. Br 2. Li d. Na |  | Pre-discussion:  Post discussion: |
| 3 | Which element requires the most energy to remove its most loosely bound electron?   1. I b. Cl c. Br d. F |  | Pre-discussion:  Post discussion: |
| 4 | Which element conducts electricity, has luster and is malleable?   1. Ca b. P c. Ge |  | Pre-discussion:  Post discussion: |
| 5 | Which element is brittle, dull, and a nonconductor?   1. Mg b. As c. S |  | Pre-discussion:  Post discussion: |
| 6 | Which elements have low ionization energies and low electronegativity values?   1. Metals 2. Nonmetals 3. metalloids |  | Pre-discussion:  Post discussion: |
| 7 | Which group will react with Oxygen in a XO ratio?   1. Group 1 c. Group 17 2. Group 2 d. Group 18 |  | Pre-discussion:  Post discussion: |
| 8 | Explain the trend in atomic radius of halogens in atomic number order. |  | Pre-discussion:  Post discussion: |
| 9 | Explain the trend of electronegativity values for elements in period 2. |  | Pre-discussion:  Post discussion: |
| 10 | Explain the trend of ionization energies for alkali metals in order of their atomic number. |  | Pre-discussion:  Post discussion: |

**Common Sense Chemistry Review Volume 4**

*You might need to know this stuff periodically.*

1. A teacher wants to use KCl for a lab that requires chloride ions in solution, but goes to the stock room and sees that there is no KCl available. What other chemicals could the teacher potentially use for the lab that may have similar properties?
2. The term alkaline is often used to denote substances that are basic. Most bases are a metallic hydroxide or metallic oxide chemical. What metals make up the alkaline chemicals?
3. Since the late 1800s, halogen lights have been used because the bulb can withstand higher temperatures without shattering. What gas(es) could be used in the halogen light bulbs?
4. Iron rusts red (think: nails), nickel rusts green (think: nickel coins), copper rusts blue-green (think: pennies and the statue of liberty) gold rusts green (think: bad gold rings), however, magnesium rusts white (think: empirical formula lab) and aluminum rusts colorless/white.
   1. What is the major chemical difference in the colored rusts versus the white rusts?
   2. When they rust they are forming oxide layers. Why is oxygen so reactive with metals?
5. A use for argon is in historical preservation. The gas is pumped around important documents such as a map of the world dating back to 1507 in the Library of Congress, and a copy of the Magna Carta held by the U.S. National Archives. The argon doesn't degrade the paper or ink on delicate documents. Why doesn’t argon react?
6. Krypton isn’t just a fictional planet that birthed Superman. Researchers dubbed this discovery "krypton," from the Greek word for "hidden," kryptos. Why was it “hidden”?
7. Most electronic circuits require the use of semiconductors including silicon, germanium and arsenic. What similarities do these elements have that gives them the semiconducting property? What other chemicals may be used as semiconductors?