2023-2024 AP Chemistry Summer Assignment

AP Chemistry is a fast-paced, challenging course that, if you are prepared to work hard and maintain focus throughout the school year, can be very fulfilling. Prior to the start of the school year, you will be expected to learn **Unit 1: Atomic Structure and Properties** on your own. For those of you that have previously taken a chemistry course at Salisbury, most of the unit will be review; for those who have not previously taken a chemistry course at Salisbury, this unit will give you a preview into the rigor and pace of the course. During the two weeks of the 2023-2024 school year, you will be assigned an in-class assessment that will allow you to demonstrate your understanding of the work that you completed over the summer. If you have questions, you may contact me at kcolling@salisburyschool.org.

Step 1:	Print this document.
Step 2:	View the Significant Figures Review video. Take notes below on significant figures and complete page 2.
Step 3:	Starting at the top of page 3, click on the link to **Video #1: Topics 1.1-1.3.** This will take you to a YouTube video that works through each problem listed. When you are finished with Topics 1.1-1.3, you will come to **Video #2: Topics 1.4-1.6.** Complete those problems; repeat for **Video #3: Topics 1.7-1.8.**

Note: the videos and questions used in this document are adapted from materials created by Michael Farabaugh.

Significant Figures Notes

Significant Figures Problems

1. For each problem, write whether the number is significant or not significant, then determine the number of significant figures in each measurement.

   a. Nonzero = ________________________________

      0.245 = _____ significant figures
      2943.34 = _____ significant figures
      3234 ____ significant figures

   b. Zeros between Nonzeros = ________________________________

      98004 = _____ significant figures
      9.003 = _____ significant figures
      2.09 _____ significant figures

   c. Zeros to the left (front) of Nonzeros = ________________________________

      - These are simply placeholders.

      0.00078 = _____ significant figures
      0.234 = _____ significant figures
      0.04 _____ significant figure

   d. Zeros at the End After the Decimal = ________________________________

      - If they didn't mean something, they wouldn't be there!

      4.67000 = _____ significant figures
      2.30 = _____ significant figures
      4.0 _____ significant figures

   e. Zeros at the End of a Measurement Before the Decimal Point = ________________________________

      - These simply serve as placeholders to show the magnitude of the number.

      4500 = _____ significant figures
      20000 = _____ significant figure
      383900000 = _____ significant figures

2. Solve the following problems, obeying the rules of significant figures and their operations.

   a. $0.008\ m + 0.05\ m =$

   b. $500\ 009\ cm^2 \div 17.000\ cm =$

   c. $22.4420\ s + 56.981\ s =$

   d. $200\ m \times 3.58\ m =$

   e. $67.5\ m/s - 0.009\ m/s =$

   f. $71.86\ g - 13.1\ g =$

   g. $8.20\ mL + 2\ mL =$

   h. $2.15\ g \times 500\ 000\ g \div 5.002\ g =$

Video #1: Topics 1.1-1.3

1.1: Moles and Molar Mass

The particles of a substance can be described as atoms, molecules, or formula units, as shown in the following examples. The molar mass of a substance can be determined or calculated from the atomic mass values on the periodic table.

1 mol Mg = 24.30 g Mg = $6.02*10^{23}$ atoms Mg

1 mol CO_2 = 44.01 g CO_2 = $6.02*10^{23}$ molecules CO_2

1 mole NaCl = 58.44 g NaCl = $6.02*10^{23}$ formula units NaCl

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1. Calculate the mass, in grams, of 0.0850 mol $Ba(OH)_2$.

2. Calculate the number of moles of C_4H_{10} present in 2.00 g C_4H_{10}.

3. Calculate the number of atoms of Si present in 35.0 mol Si.

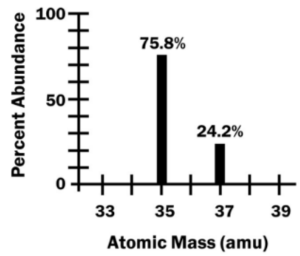
4. Calculate the number of moles of O_3 present in $4.3*10^{24}$ molecules of O_3.

5. Calculate the mass, in grams, of $8.2*10^{22}$ molecules of $CHCl_3$.

6. Calculate the number of formula units of Na_2SO_4 present in 0.248 g Na_2SO_4.

1.2: Mass Spectroscopy of Elements

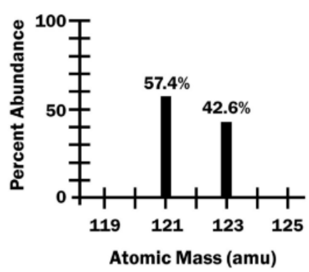
Isotope	Abundance
Cl-35	75.8%
Cl-37	24.2%



7. Based on the information shown above:
   a. Calculate the average atomic mass of Cl.

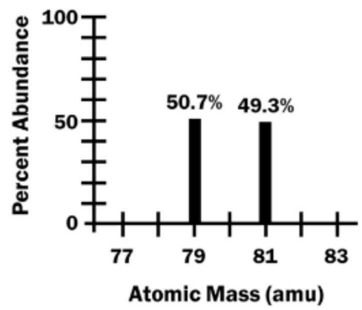
   b. Fill in the table below.

Isotope	Protons	Neutrons
Cl-35		
Cl-37		



8. Based on the information shown above:
   a. Calculate the average atomic mass of the element.

   b. What is the most likely identity of the element? ________________________________



9. Based on the information shown above:
   a. What is the most likely identity of the element? ________________________________

   b. Fill in the table below.

Mass Number	Protons	Neutrons
79		
81		

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10. A certain element has two naturally occurring isotopes with mass numbers of 63 and 65.
   a. What is the most likely identity of this element? ________________________________

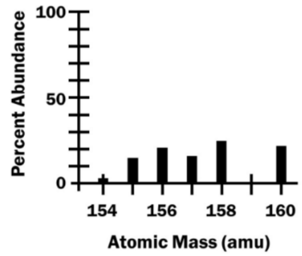
   b. Fill in the table below.

Mass Number	Protons	Neutrons
63		
65		

   c. Which isotope of this element, mass number = 63 or mass number = 65, is more abundant in nature? Justify your answer.

11. If an element has several naturally occurring isotopes, the calculation of the average atomic mass of the element can be a bit more complicated.

Mass Number	Abundance
154	2.18%
155	14.80%
156	20.47%
157	15.65%
158	24.84%
160	22.06%



a. Based on the information above, estimate the average atomic mass of the element to the nearest whole number. Then use a calculator to determine the average atomic mass.

b. What is the most likely identify of the element? ________________________________

1.3: Elemental Composition of Pure Substances

12. Calculate the percent composition by mass of each element in glucose ($C_6H_{12}O_6$).

13. Calculate the percent composition by mass of each element in erythrose ($C_4H_8O_4$).

14. What is the empirical formula of glucose? ________________________________

What is the empirical formula of erythrose? ________________________________

***Two different compounds with the same empirical formula have the same percent composition by mass.**

15. A certain compound has the following percent composition by mass.

43.64% P   56.36% O

Determine the empirical formula of this compound.

Important

If you are given mass data for a certain compound, the following procedure will help you determine the empirical formula of the compound.

- Convert the mass of each element into moles.
- Divide each value of moles by the lowest number of moles.
- You may already have whole numbers for the moles of each element. If not, you may need to multiply by 2 or 3 in order to get whole numbers.
- Use the whole number values of moles to write the empirical formula.

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16. A certain compound has the following percent composition by mass.

52.14% C   13.13% H   34.73% O

Determine the empirical formula of this compound.

17. A pure sample of tin (Sn) with a mass of 6.18 g is burned in air until the tin is completely converted into tin oxide. The mass of the tin oxide is equal to 7.85 g. Determine the empirical formula of the tin oxide compound.

18. Compound X consists of the elements C, H, and N. A 15.00-g sample of compound X contains 9.81 g C, 1.37 g H, and 3.82 g N.
    a. Determine the empirical formula of compound X.

    b. It is determined that a 25.0-g sample of compound C contains $9.11*10^{22}$ molecules. Calculate the molar mass of compound X, in units of g/mol.

    c. Determine the molecular formula of compound X.

Important
A combustion reaction is as follows:

$$\text{Hydrocarbon (C, H, and/or O) (g)} + O_2\text{ (g)} \rightarrow CO_2\text{ (g)} + H_2O\text{ (g)}$$

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19. A sample of a compound that contains carbon, hydrogen, and oxygen is burned completely in O_2. Data from the combustion experiment is shown in the table below.

Mass of sample that is burned	5.00 g
Mass of CO_2 produced	10.99 g
Mass of H_2O produced	6.00 g

a. Determine the mass of carbon present in 5.00 g of the compound.

b. Determine the mass of hydrogen present in 5.00 g of the compound.

c. Determine the mass of oxygen present in 5.00 g of the compound.

d. Determine the empirical formula of the compound.

Important

Another type of situation that involves mass and mole ratios involves a substance known as a hydrate. A hydrate is a substance in which water molecules are included in the chemical formula. These substances are often ionic compounds in which water molecules are bonded to the ions in the crystal structure. A hydrated salt can be heated to remove the water through evaporation, forming an anhydrous salt. Two examples of anhydrous salts and hydrates are listed in the table below.

Anhydrous Salt	Hydrate Salt
Copper (II) sulfate, $CuSO_4$	Copper (II) sulfate pentahydrate, $CuSO_4{\bullet}5H_2O$
Calcium chloride, $CaCl_2$	Calcium chloride dyhydrate, $CaCl_2{\bullet}2H_2O$

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20. A sample of $CuSO_4{\bullet}5H_2O$ has a mass of 25.00 g.
    a. Calculate the mass of $CuSO_4$ in this 25.00-g sample.

    b. Calculate the mass of H_2O in this 25.00-g sample.

21. Calculate the percent of H_2O by mass in $CaCl_2{\bullet}2H_2O$.

22. In a certain experiment, a sample of a hydrate of magnesium sulfate, $MgSO_4 \bullet nH_2O$, is heated in order to remove all of the water from the sample. Experimental data is shown in the table below.

Mass of empty container	25.356 g
Mass of container and hydrate salt, before heating	28.418 g
Mass of container and sample after 1st heating	26.931 g
Mass of container and sample after 2nd heating	26.853 g
Mass of container and sample after 3rd heating	26.852 g

a. Explain how the data indicates that all of the water has been removed from the hydrate salt in this experiment.

b. Calculate the mass of the hydrate salt used in this experiment.

c. Calculate the mass of water that was removed from the hydrate sample in this experiment.

d. Determine the value of *n* in the formula $MgSO_4 \bullet nH_2O$.

Video #2: Topics 1.4-1.6

1.4: Composition of Mixtures

1. Answer the following questions about the mixture whose composition is listed in the table below.

Mass of NaCl	Mass of $MgCl_2$	Total Mass of Mixture
2.75 g	3.42 g	6.17 g

   a. Calculate the percentage of NaCl by mass in this mixture.

   b. Calculate the percentage by Na by mass in this mixture.

   c. Calculate the percentage of Cl by mass in this mixture.

2. A sample of a solid labeled as $AgNO_3$ may be impure. A student analyzes the sample, and determines that it contains 68% Ag by mass.
   a. Calculate the percentage of Ag by mass in a pure sample of $AgNO_3$.

   b. Which of the following is more likely to represent the solid sample that was analyzed? Justify your answer.

A mixture of $AgNO_3$ and AgCl	A mixture of $AgNO_3$ and AgBr

3. A student needs to analyze a mixture that contains $BaCl_2$ and NaCl. The student dissolves a 6.75-g sample of this mixture completely into water and adds an excess amount of Na_2SO_4 (aq). A white precipitate of $BaSO_4$ (s) is formed, based on the following chemical equation:

$$BaCl_2\ (aq) + Na_2SO_4\ (aq) \rightarrow 2NaCl\ (aq) + BaSO_4\ (s)$$

The solid precipitate is filtered, dried, and weighted, and its mass is recorded as 2.36 g.

a. Calculate the number of moles of $BaSO_4$ (s) that is recovered in this experiment.

b. Calculate the percentage of $BaCl_2$ by mass in this mixture.

4. A mixture of $CaCO_3$ and Na_2CO_3 is found to contain 35.00% Na by mass. Calculate the percentage of Na_2CO_3 by mass in this mixture.

1.5: Atomic Structure and Electron Configuration

5. The valence electrons of both Na and Mg are located in the 3^{rd} energy level. Which atom, Na or Mg, experiences a greater attractive force between the nucleus and valence electrons? Justify your answer in terms of Coulomb's law.

6. The valence electron of Na is located in the 3rd energy level, whereas the valence electron of K is located in the 4th energy level. Which atom, Na or K, experiences a greater attractive force between the nucleus and the valence electron? Justify your answer in terms of Coulomb's law.

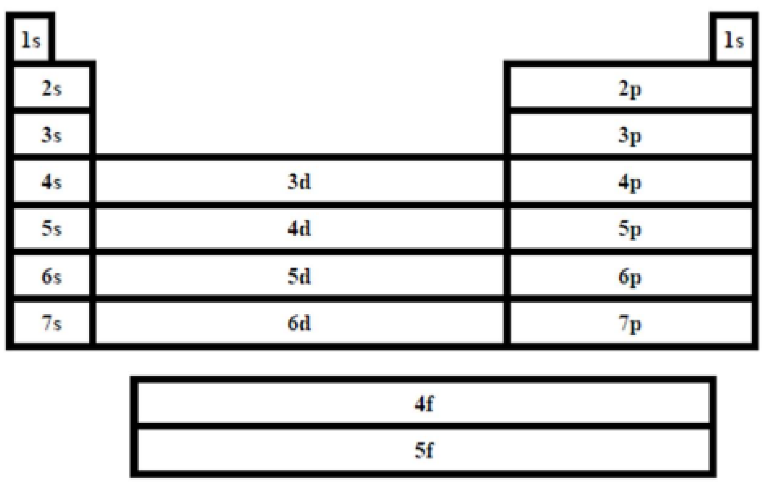
7. Ionization energy (IE) is normally expressed in units of kilojoules per mole, and is defined as the energy required to remove one mole of electrons from one mole of gaseous atoms (or ions) in their ground states. This process is represented below.

$$X\ (g) + \text{ionization energy} \rightarrow X^{+}\ (g) + e^{-}$$

Based on your answers to Questions #5 and #6, arrange the atoms Na, Mg, and K in order of increasing ionization energy value.

Lowest IE		**Highest IE**

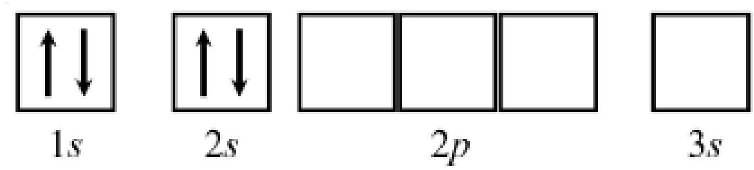
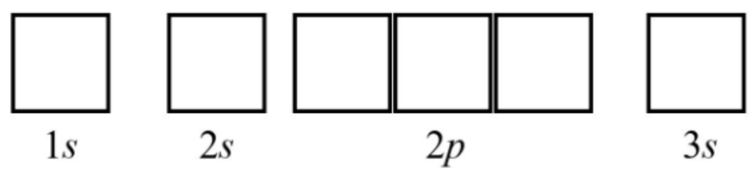
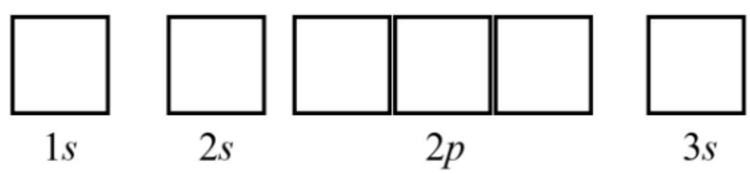
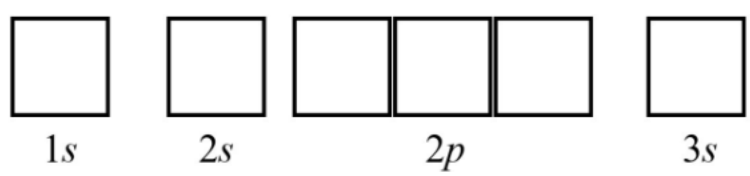
Important
The electron configuration is the distribution of the electrons in an atom or an ion among the various orbitals. There are patters on the periodic table that help you write the electron configuration of an atom or an ion.



8. Fill in the missing information in the table below.

Symbol	Atomic Number	Electron Configuration	Noble Gas Electron Configuration
O	8	$1s^22s^22p^4$	[He] $2s^22p^4$
			[Ne] $3s^23p^1$
Ca		$1s^22s^22p^63s^23p^64s^2$	
	26		
As			
Cd			

9. Fill in the missing information in the table below.

Element Symbol	Atomic Number	Orbital Diagram for the Electron Configuration
Be	4	
N	7	
O	8	
Na	11	

Important
The **ground state** electron configuration refers to the arrangement of the electrons in the lowest available energy levels. An **excited state** electron configuration refers to a situation in which at least one of the electrons has moved up to a higher energy level.

10. Circle all of the following that represent an excited state electron configuration.

$1s^2 2s^2 2p^6 3s^2 3p^1$ $1s^2 2s^2 2p^5 3s^1$ $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$

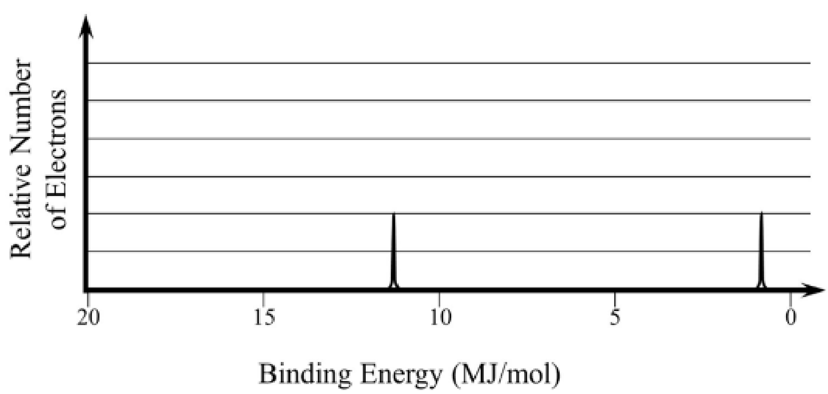
$1s^2 2s^1 2p^2$ $1s^2 2s^2 2p^6 3s^2 3p^4$ $1s^2 2s^2 2p^6 3s^1 3p^1$

11. Write the ground state electron configuration for each of the following ions.

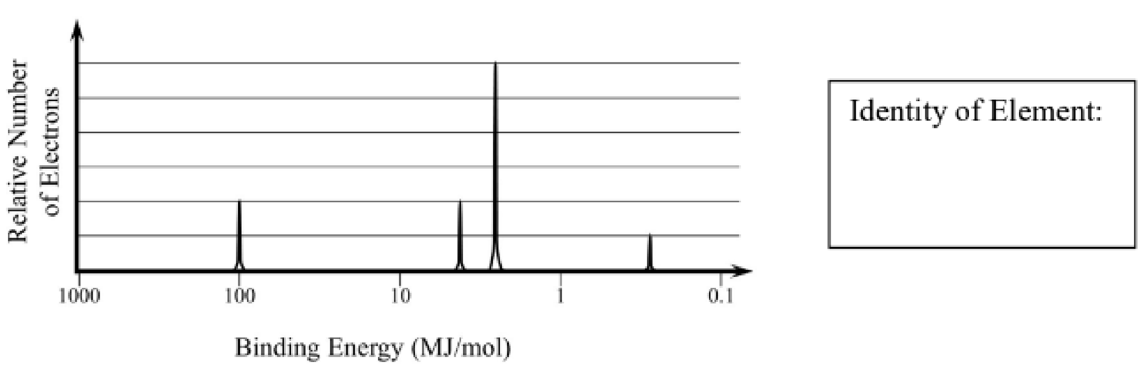
Ca^{2+} ____ Fe^{2+} ____

O^{2-} ____ Fe^{3+} ____

1.6: Photoelectron Spectroscopy



12. On the PES diagram above, there are two peaks. Draw a circle around the peak that represents the electrons that are located closer to the atomic nucleus. Justify your answer in terms of Coulomb's law.

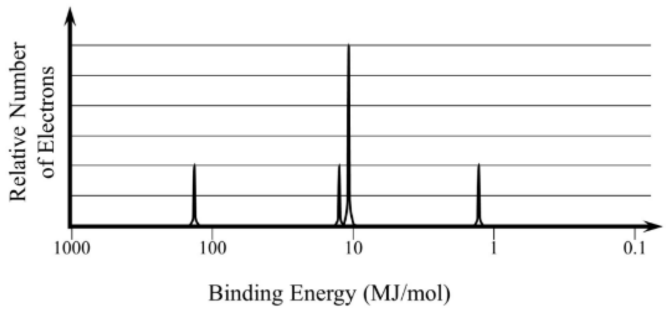


13. On the PES diagram above, label each peak as one of the following:

1s, 2s, 2p, or 3s. Identify the element that is represented by this PES diagram.

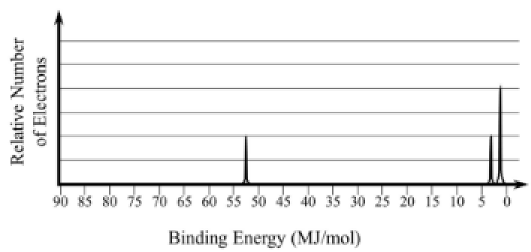
	Binding Energy (MJ/mol)
1s electrons in nitrogen (N)	39.6
1s electrons in oxygen (O)	52.6

14. The table above shows the binding energy for the 1s electrons in a nitrogen atom and the binding energy for the 1s electrons in an oxygen atom. Explain the difference in these two values in terms of Coulomb's law and atomic structure.

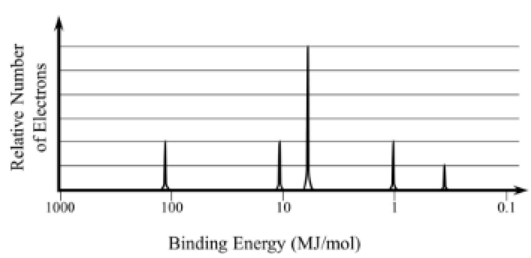


15. A partial photoelectron spectrum of pure phosphorus (P) is shown above. On the spectrum above, draw the missing peak that corresponds to the electrons in the 3p level.

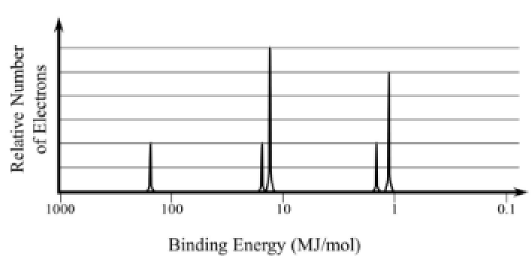
16. The photoelectron spectrum diagrams for three different elements are shown below. Identify the element that is represented by each diagram.



Identity of Element:



Identity of Element:



Identity of Element:

Video #3: Topics 1.7-1.8

1.7: Periodic Trends

Coloumb's law describes the force between two charged particles. This equation is useful when studying periodic trends.

Coulomb's Law	Variables
$F \propto \frac{q_1 q_2}{r^2}$	F = force between to particles
	q_1 = electrical charge on particle 1
	q_2 = electrical charge on particle 2
	r = distance between the two particles

When comparing the atoms of two different element that are located in the same period (row):

- The valence electrons of each atom are located in the same energy level.
- The element with more protons has a greater nuclear charge, and there is a stronger attraction between the nucleus and the valence electrons.
- According to Coulomb's law, the greater the magnitude of the charge, the stronger the attractive force between oppositely charged particles.

When comparing the atoms of two different elements that are located in the same group (column):

- The valence electrons of each atom are located in different energy levels.
- Electrons located in a higher energy level are farther away from the nucleus.
- Electrons locared in a lower energy level are closer to the nucleus.
- According to Coulomb's law, the smaller the distance between oppositely charged particles, the greater the attractive force between them.

1. Which element, Li or Be, has a smaller atomic radius? Justify your answer in terms of atomic structure and Coulomb's law.

2. Which element, Li or Na, has a smaller atomic radius? Justify your answer in terms of atomic structure and Coulomb's law.

3. Based on your answers to Questions #1 and #2, arrange the atoms Li, Be, and Na in order of increasing atomic radius.

Smallest		Largest

4. The atomic radius of the Na atom is different than the ionic radius of the Na^+ ion.
   a. Write the complete ground state electron configuration for Na and for Na^+.

      Na ________________________________ Na^+ ________________________________

   b. Which particle, Na or Na^+, has a larger radius? Justify your answer in terms of atomic structure.

Ion	Ionic Radius (pm)
Fe^{2+}	92
Fe^{3+}	79

5. The ionic radii of two different ions are shown in the table above.
   a. Write the ground state electron configuration for Fe^{2+} and Fe^{3+}.

      Fe^{2+} ________________________________ Fe^{3+} ________________________________

   b. In terms of atomic structure, explain why the radius of Fe^{2+} is larger than that of Fe^{3+}.

6. The atomic radius of the F atom is different than the ionic radius of the F^- ion.
   a. Write the complete ground state electron configuration for F and for F^-.

      F ________________________________ F^- ________________________________

   b. Which particle, F or F^-, has a larger radius? Justify your answer in terms of atomic structure.

K^+	Ca^{2+}	S^{2-}	Cl^-

7. Each of the ions shown in the table above are members of an isoelectronic series. This means that each ion has the same number of electrons.
    a. Arrange these ions in order of increasing ionic radius.

Smallest			**Largest**

    b. Justify your answer.

Ionization energy is normally expressed in units of kilojoules per mole, and is defined as the energy required to remove one mole of electrons from one mole of gaseous atoms (or ions) in their ground states. Removing the outermost electron from a neutral atom is called the *first ionization energy* (IE_1). Removing the outermost electron from a +1 ion is called the *second ionization energy* (IE_2), etc.

$Mg (g) \rightarrow Mg^+ (g) + e^-$ IE_1 = 738 kJ/mol

$Mg^+ (g) \rightarrow Mg^{2+} (g) + e^-$ IE_2 = 1451 kJ/mol

$Mg^{2+} (g) \rightarrow Mg^+ (g) + e^-$ IE_3 = 7733 kJ/mol

8. As you move from left to right across a horizontal row (period) on the periodic table, atomic radius values tend to _________________________ from left to right, and first ionization energy values tend to _________________________ from left to right.
9. As you move from top to bottom down a vertical column (group) on the periodic table, atomic radius values tend to _________________________ from top to bottom, and first ionization energy values tend to _________________________ from top to bottom.

Important

On the AP Exam,

- You will NOT earn credit for simply referring to the relative position of the elements on the periodic table without an explanation.
- You will NOT earn credit for using one trend to explain another trend.

Question: Explain why the first ionization energy of Mg (738 kJ/mol) is greater than the first ionization energy of Na (496 kJ/mol).	
Ionization energy increases from left to right across a period. Therefore it requires more energy to remove a valence electron from a Mg atom than it does to remove a valence electron from a Na atom.	Unacceptable response because there is no explanation.
Mg has a smaller atomic radius than Na. Therefore it requires more energy to remove a valence electron from a Mg atom than it does to remove a valence electron from a Na atom.	Unacceptable response because it uses one trend to explain another trend.
The valence electrons in Na and Mg are located in the same energy level (n = 3). Na has 11 protons, and Mg has 12 protons. Since Mg has a greater nuclear charge than Na, there is a stronger attraction between the nucleus and valence electrons. Therefore it requires more energy to remove a valence electron from a Mg atom than it does to remove a valence electron from a Na atom.	**Acceptable** response because it uses principles of atomic structure to explain the data.

Question: Explain why the first ionization energy of K (419 kJ/mol) is greater than the first ionization energy of Na (496 kJ/mol).	
Ionization energy decreases from top to bottom down a group. Therefore it requires less energy to remove a valence electron from a K atom than it does to remove a valence electron from a Na atom.	Unacceptable response because there is no explanation.
K has a larger atomic radius than Na. Therefore it requires less energy to remove a valence electron from a K atom than it does to remove a valence electron from a Na atom.	Unacceptable response because it uses one trend to explain another trend.
Na has three occupied energy levels, and K has four occupied energy levels. The valence electron in Na is located in a 3s orbital, whereas the valence electron in K is located in a 4s orbital. Since the valence electron in K is farther away from the nucleus than the valence electron in Na, there is a weaker attraction between the nucleus and the valence electron. Therefore it requires less energy to remove a valence electron from a K atom than it does to remove a valence electron from a Na atom.	**Acceptable** response because it uses principles of atomic structure to explain the data.

Two Anomalies in the Horizonal Trend for First Ionization Energy

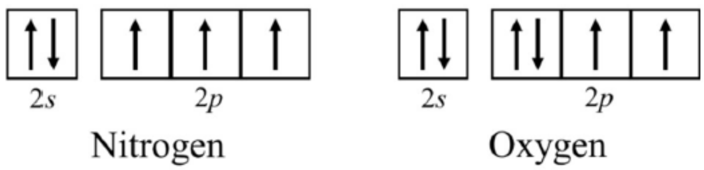
Anomaly #1 – Group 2A to 3A

Element	Li	Be	B	C
Electron Configuration	$1s^2 2s^1$	$1s^2 2s^2$	$1s^2 2s^2 2p^1$	$1s^2 2s^2 2p^2$
Ionization Energy (kJ/mol)	520	899	801	1086

Although B has one more proton than Be, the ionization energy of B is slightly less than that of Be. This decrease in ionization energy can be explained as follows: the outermost electron for B is located in the 2p subshell, whereas the outermost electron for Be is located in the 2s subshell. The 2p subshell is slightly higher in energy than the 2s subshell. It requires slightly less energy to remove an electron from the 2p subshell than it does to remove an electron from the 2s subshell.

Anomaly #2 – Group 5A to 6A

Element	C	N	O	F
Electron Configuration	$1s^22s^22p^2$	$1s^22s^22p^3$	$1s^22s^22p^4$	$1s^22s^22p^5$
Ionization Energy (kJ/mol)	1086	1402	1314	1681



Although O has one more proton than N, the ionization energy of O is slightly less than that of N. This decrease in ionization energy can be explained as follows: There is slightly more electron-electron repulsion between the paired electrons in the p^4 configuration of O as compared to the p^3 configuration of N. This electron repulsion in the p^4 configuration explains why it requires slightly less energy to remove an electron from an atom of O than it does to remove an electron from an atom of N.

Ionization Energies of Elements

	Na	Mg	Al	Si	P	S	Cl	Ar
IE_1	496	738	578	787	1,012	1,000	1,251	1,520
IE_2	4,562	1,451	1,817	1,577	1,903	2,251	2,297	2,665
IE_3	6,912	7,733	2,745	3,231	2,912	3,361	3,822	3,931
IE_4	9,543	10,540	11,575	4,356	4,956	4,564	5,158	5,770
IE_5	13,353	13,360	14,830	16,091	6,273	7,013	6,540	7,328
IE_6	16,610	17,995	18,376	19,784	22,233	8,495	9,458	8,781
IE_7	20,114	21,703	23,293	23,783	25,397	27,106	11,020	11,995
IE_8	25,496	25,661	27,465	29,287	29,872	31,719	33,604	13,842

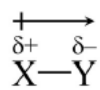
10. Consider the data for successive ionization energy in the table above.
    a. In terms of atomic structure and Coulomb's law, explain why the ionization energy values increase as successive electrons are removed from an atom.

    b. In terms of atomic structure and Coulomb's law, explain why the 2^{nd} IE for Na is much higher than the 2^{nd} IE for Mg.

Element	IE_1	IE_2	IE_3	IE_4	IE_5
X	1087	2353	4621	6223	37,831

11. Based on the information in the table above, how many valence electrons does element X have? Justify your answer.

Electronegativity is defined as the tendency of an atom to attract electrons to itself in a chemical bond. The higher the electronegativity value is, the greater the attraction for electrons. Electronegativity values are used when determining if a particular chemical bond is classified as nonpolar covalent, polar covalent, or ionic. The greater the difference in electronegativity between two atoms, the more polar the bond is. Suppose that a polar covalent bond is formed between two atoms X and Y as shown below.



If atom X is less electronegative than atom Y, there is a partial positive charge on atom X and a partial negative charge on atom Y. The arrow above the polar covalent bond represents the dipole, which is generated whenever two electrical charges of opposite sign are separated by a distance. The arrow always points to the atom that has the higher electronegativity value. The measure of the magnitude of the dipole is called the dipole moment. In general, the greater the difference in electronegativity, the greater the magnitude of the dipole moment.

Electronegativity Values

H 2.1						
Li 1.0	Be 1.5	B 2.0	C 2.5	N 3.0	O 3.5	F 4.0
Na 0.9	Mg 1.2	Al 1.5	Si 1.8	P 2.1	S 2.5	Cl 3.0
K 0.8	Ca 1.0	Ga 1.6	Ge 1.8	As 2.0	Se 2.4	Br 2.8
Rb 0.8	Sr 1.0	In 1.7	Sn 1.8	Sb 1.9	Te 2.1	I 2.5

Notice that the noble gases (He, Ne, Ar, etc.) are not included in the data above. This is because the atoms of the noble gases ordinarily do not form chemical bonds or share electrons with other atoms.

12. As you move from left to right across a horizontal row (period) on the periodic table, electronegativity values tend to ________________________ from left to right. As you move from top to bottom down a vertical column (group) on the periodic table, electronegativity values tend to ________________________ from top to bottom.

13. The smaller the atomic radius, the ________________________ the electronegativity value is. The larger the atomic radius, the ________________________ the electronegativity value is. The most electronegative element on the periodic table is ________________________.

Electron affinity is a a periodic trend that can be confusing to understand. Electron affinity is defined as the energy change that occurs when an electron is added to a gaseous atom to form a negatively charged anion. Consider the following examples.

$F (g) + e^- \rightarrow F^- (g)$ ΔE = -328 kJ/mol

$Li (g) + e^- \rightarrow Li^- (g)$ ΔE = -60 kJ/mol

If ΔE is negative, energy is released. If ΔE is positive, energy is absorbed. The greater the attraction is between an atom and an added electron, the more negative the value of ΔE is. The more negative the value of ΔE is, the greater the electron affinity is. As you can see in the table below, the trends in electron affinity are not necessarily clear and predictable.

In general, more energy is released when a nonmetal atom gains an electron than when a metal atom gains an electron. For the noble gases, the electron affinity has a positive value. This indicates that the X^-(g) ion is less stable than the X(g) atom.

Electron Affinity (kJ/mol)

H –73							He +48
Li –60	Be +48	B –27	C –122	N +7	O –141	F –328	Ne +116
Na –53	Mg +40	Al –42	Si –134	P –72	S –200	Cl –349	Ar +96
K –48	Ca –2	Ga –29	Ge –119	As –78	Se –195	Br –325	Kr +96

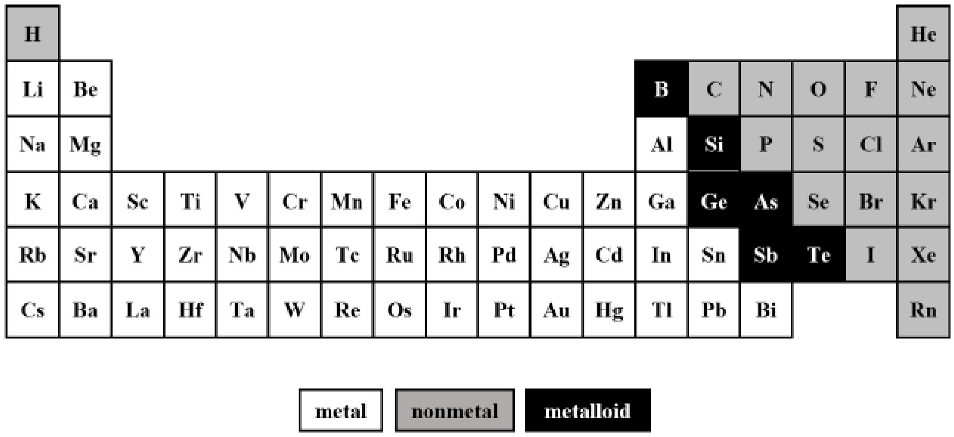
1.8: Valence Electrons and Ionic Compounds

14. Write the correct number of valence electrons for each of the following atoms.

Element	Li	Be	B	C	N	O	F	Ne
Valence Electrons								

15. Write the correct charge that each of the following elements has when it forms an ion.

Element	Li	Be	B	C	N	O	F	Ne
Charge				N/A				



Binary compounds (e.g., NaCl) normally consist of a metal and a nonmetal. The chemical formula of a binary ionic compound can be determined by examining the charges on each ion. The formula is written as an empirical formula and should have an overall charge of zero.

16. Write the correct chemical formula for the binary ionic compound that is formed from the combination of each of the following pairs of elements.

Elements	Chemical Formula
Li and F	
Na and S	
Mg and Cl	
Al and O	
Ca and P	

Elements in the same group (column) of the periodic table have the same number of valence electrons. This explains why elements in the same group tend to form analogous compounds.

Periodic Table of the Elements

Chemistry Reference Sheet

California Standards Test

Key

11 — Atomic number
Na — Element symbol
Sodium — Element name
22.99 — Average atomic mass*

	1 1A	2 2A	3 3B	4 4B	5 5B	6 6B	7 7B	8	9 8B	10	11 1B	12 2B	13 3A	14 4A	15 5A	16 6A	17 7A	18 8A
1	1 **H** Hydrogen 1.01																	2 **He** Helium 4.00
2	3 **Li** Lithium 6.94	4 **Be** Beryllium 9.01											5 **B** Boron 10.81	6 **C** Carbon 12.01	7 **N** Nitrogen 14.01	8 **O** Oxygen 16.00	9 **F** Fluorine 19.00	10 **Ne** Neon 20.18
3	11 **Na** Sodium 22.99	12 **Mg** Magnesium 24.31											13 **Al** Aluminum 26.98	14 **Si** Silicon 28.09	15 **P** Phosphorus 30.97	16 **S** Sulfur 32.07	17 **Cl** Chlorine 35.45	18 **Ar** Argon 39.95
4	19 **K** Potassium 39.10	20 **Ca** Calcium 40.08	21 **Sc** Scandium 44.96	22 **Ti** Titanium 47.87	23 **V** Vanadium 50.94	24 **Cr** Chromium 52.00	25 **Mn** Manganese 54.94	26 **Fe** Iron 55.85	27 **Co** Cobalt 58.93	28 **Ni** Nickel 58.69	29 **Cu** Copper 63.55	30 **Zn** Zinc 65.39	31 **Ga** Gallium 69.72	32 **Ge** Germanium 72.61	33 **As** Arsenic 74.92	34 **Se** Selenium 78.96	35 **Br** Bromine 79.90	36 **Kr** Krypton 83.80
5	37 **Rb** Rubidium 85.47	38 **Sr** Strontium 87.62	39 **Y** Yttrium 88.91	40 **Zr** Zirconium 91.22	41 **Nb** Niobium 92.91	42 **Mo** Molybdenum 95.94	43 **Tc** Technetium (98)	44 **Ru** Ruthenium 101.07	45 **Rh** Rhodium 102.91	46 **Pd** Palladium 106.42	47 **Ag** Silver 107.87	48 **Cd** Cadmium 112.41	49 **In** Indium 114.82	50 **Sn** Tin 118.71	51 **Sb** Antimony 121.76	52 **Te** Tellurium 127.60	53 **I** Iodine 126.90	54 **Xe** Xenon 131.29
6	55 **Cs** Cesium 132.91	56 **Ba** Barium 137.33	57 **La** Lanthanum 138.91	72 **Hf** Hafnium 178.49	73 **Ta** Tantalum 180.95	74 **W** Tungsten 183.84	75 **Re** Rhenium 186.21	76 **Os** Osmium 190.23	77 **Ir** Iridium 192.22	78 **Pt** Platinum 195.08	79 **Au** Gold 196.97	80 **Hg** Mercury 200.59	81 **Tl** Thallium 204.38	82 **Pb** Lead 207.2	83 **Bi** Bismuth 208.98	84 **Po** Polonium (209)	85 **At** Astatine (210)	86 **Rn** Radon (222)
7	87 **Fr** Francium (223)	88 **Ra** Radium (226)	89 **Ac** Actinium (227)	104 **Rf** Rutherfordium (261)	105 **Db** Dubnium (262)	106 **Sg** Seaborgium (266)	107 **Bh** Bohrium (264)	108 **Hs** Hassium (269)	109 **Mt** Meitnerium (268)									

58 **Ce** Cerium 140.12	59 **Pr** Praseodymium 140.91	60 **Nd** Neodymium 144.24	61 **Pm** Promethium (145)	62 **Sm** Samarium 150.36	63 **Eu** Europium 151.96	64 **Gd** Gadolinium 157.25	65 **Tb** Terbium 158.93	66 **Dy** Dysprosium 162.50	67 **Ho** Holmium 164.93	68 **Er** Erbium 167.26	69 **Tm** Thulium 168.93	70 **Yb** Ytterbium 173.04	71 **Lu** Lutetium 174.97
90 **Th** Thorium 232.04	91 **Pa** Protactinium 231.04	92 **U** Uranium 238.03	93 **Np** Neptunium (237)	94 **Pu** Plutonium (244)	95 **Am** Americium (243)	96 **Cm** Curium (247)	97 **Bk** Berkelium (247)	98 **Cf** Californium (251)	99 **Es** Einsteinium (252)	100 **Fm** Fermium (257)	101 **Md** Mendelevium (258)	102 **No** Nobelium (259)	103 **Lr** Lawrencium (262)

* If this number is in parentheses, then it refers to the atomic mass of the most stable isotope.