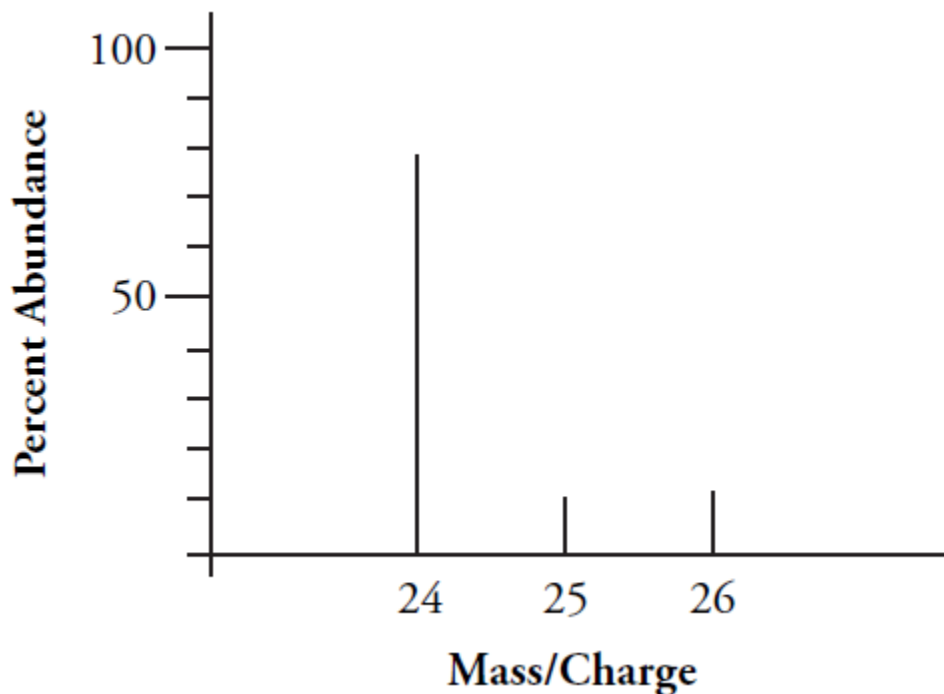


Unit 1 Online Review

Atomic structure and properties

1. A 26.00-g sample of a hydrocarbon (a compound that contains the elements hydrogen and carbon) was analyzed and found to contain 21.87 g of carbon.
 - a. How many grams of hydrogen are present in this sample?
 - b. Determine the percentage composition for each element in this compound.
 - c. How many grams of each element are present in a 15.50-g sample?
 - d. Determine the empirical formula for this compound.
 - e. The molar mass of this compound is 171.4 g mol^{-1} . Determine the molecular formula for this compound.
2. How many grams of hydrogen are in 50.90 g of ammonia?
3. A 2.500 g sample of ethylene glycol, which contains carbon, hydrogen, and oxygen, is combusted and analyzed. The combustion yields 3.545 g of carbon dioxide and 2.168 g of water.
 - a. Determine the empirical formula of ethylene glycol.
 - b. If ethylene glycol has a molar mass of 62.1 g mol^{-1} , calculate the molecular formula.
4. Answer the following questions about the mass spectrum below:



- a. What does the mass spectrum tell us?
- b. Estimate (no calculator or calculations) the average atomic mass of the element.

- c. Calculate the average atomic mass of the element (with calculator).
 - d. Identify the element using the periodic table.
 - e. Write the electron configuration of the element.
5. A hydrate of magnesium chloride is dehydrated. Use the following data to determine the percent of water in the hydrate and the empirical formula:

Mass of empty container	22.347 g
Initial mass of sample and container	25.825 g
Mass of sample and container after first heating	23.982 g
Mass of sample and container after second heating	23.976 g
Mass of sample and container after third heating	23.977 g

- a. Explain why you can correctly conclude that the hydrate was heated a sufficient number of times in the experiment.
- b. Use the data to calculate the percent of water in the hydrate.
- c. Calculate the empirical formula of the compound.
- d. Your slacker lab partner is too lazy to cover the crucible and some of the solid splatters out. What effect will this have on the calculated empirical formula? Justify your answer.

$$F_{\text{coulombic}} \propto \frac{q_1 q_2}{r^2}$$

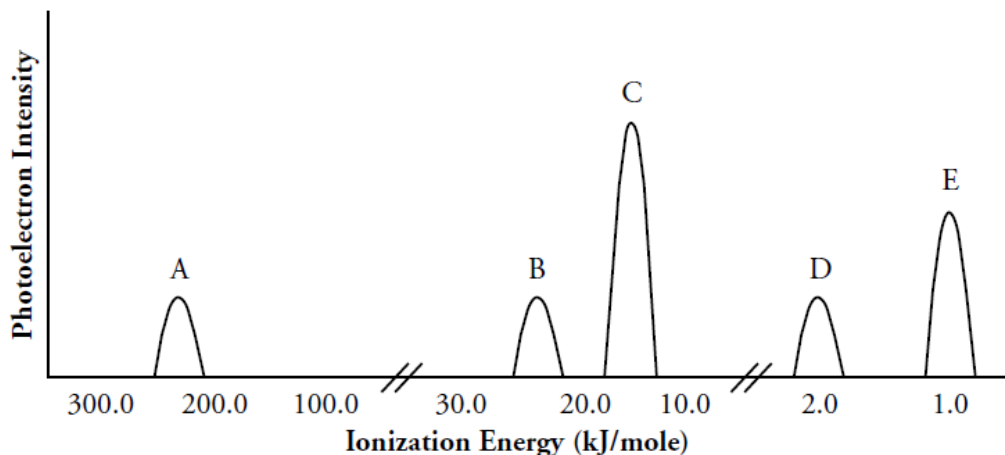
6. Coulomb's law is
- a. Describe the relationship between force and the charge of one species, q_1 . If the charge doubles, what happens to force?
 - b. Describe the relationship between force and the distance between the two charged objects, r . If the distance doubles, what happens to force?
 - c. How does Coulomb's law relate to an atom?
7. An element has the following ionization energies:

Ionization	1 st	2 nd	3 rd	4 th	5 th	6 th
Energy in kJ/mol	737	1450	7732	10540	13360	17995

- a. How many valence electrons are in an atom of this element?
 - b. What group is this element in? Explain.
 - c. Based on your answer to part b and the chart above, which element(s) could this not be? Why?
 - d. Predict the formula resulting from the reaction of this element with fluorine.
8. Answer the following questions about electron configurations:
- a. Write the full electron configurations for boron, phosphorus, and cobalt.
 - b. Write the electron configurations for the chloride ion, aluminum ion, and silver ion.

- c. Write the orbital diagrams for silicon and lithium.
- d. Use orbital diagrams to illustrate what happens when a sulfur atom gains two electrons.

9. Answer the following questions based on the PES diagram below:



- a. Write the electron configuration for the element.
 - b. Identify the element with one fewer protons in the nucleus. Would the ionization energy for peak A of this be greater or less than the IE shown in the diagram above? Explain your answer.
 - c. On the diagram above, carefully draw the corresponding peak E you would expect for an atom with one additional proton in the nucleus. Explain any differences between your sketch and the original diagram.
10. How would you expect the sizes of the hydrogen ion, H^+ , and the hydride ion, H^- , to compare with that of the hydrogen atom?
 11. Identify any isoelectronic species in this list: Fe^{2+} , Sc^{3+} , Ca^{2+} , F^- , Co^{2+} , Co^{3+} , Sr^{2+} , Cu^+ , Zn^{2+} and Al^{3+} .
 12. Arrange the following species in order of increasing atomic size: Rb^+ , Y^{3+} , Br^- , Kr , Sr^{2+} and Se^{2-} .
 13. Arrange the following atoms into order of increasing first ionization energy: Sr , Cs , S , F and As .
 14. Explain why iodine has a smaller atomic radius than strontium.
 15. Explain why iodine has a larger atomic radius than fluorine.
 16. Which has the larger ionization energy, chlorine or calcium? Explain.
 17. Which has the larger electron affinity, osmium or gallium? Explain.

18. Write equations that show the processes that describe the first, second, and third ionization energies of a calcium atom. Is this an endo- or exothermic process? Which would release/require the least amount of energy? Which would release/require the most energy?
19. Write equations that show the processes that describe the first and second electron affinities of an oxygen atom. Is this an endo- or exothermic process? Which would release/require the least amount of energy? Which would release/require the most energy?

AP Questions

1.

Using principles of atomic and molecular structure and the information in the table below, answer the following questions about atomic fluorine, oxygen, and xenon, as well as some of their compounds.

Atom	First Ionization Energy (kJ mol ⁻¹)
F	1,681.0
O	1,313.9
Xe	?

- (a) Write the equation for the ionization of atomic fluorine that requires 1,681.0 kJ mol⁻¹.
- (b) Account for the fact that the first ionization energy of atomic fluorine is greater than that of atomic oxygen. (You must discuss both atoms in your response.)
- (c) Predict whether the first ionization energy of atomic xenon is greater than, less than, or equal to the first ionization energy of atomic fluorine. Justify your prediction.
- 2.
- Account for the following observations using principles of atomic structure and/or chemical bonding. In each part, your answer must include specific information about both substances.
- (a) The Ca²⁺ and Cl⁻ ions are isoelectronic, but their radii are not the same. Which ion has the larger radius? Explain.
- (b) Carbon and lead are in the same group of elements, but carbon is classified as a nonmetal and lead is classified as a metal.
- (c) Compounds containing Kr have been synthesized, but there are no known compounds that contain He.
- (d) The first ionization energy of Be is 900 kJ mol⁻¹, but the first ionization energy of B is 800 kJ mol⁻¹.