

## Chapter 5: Atomic Structure and the Periodic Table

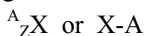
### Part I: Notes – Introduction to Isotopes

- Objectives:** Identify, define, and explain: atomic number, zero net charge, atomic mass, mass number, isotope, nuclear charge, atomic mass unit, proton, neutron, electron, and nucleus.  
Distinguish among protons, neutrons, and electron in terms of relative mass, charge, and size.  
Describe the structure of an atom, including  $p^+$ ,  $n^0$ , and  $e^-$  with respect to the nucleus and an atom's relative size.  
Explain how atomic number identifies an element and how isotopes differ from one another.  
Write isotopes in correct notation and use notation to determine information about  $p^+$ ,  $n^0$ , and  $e^-$  of an isotope.

**Text Reference:** Section 5.3 (Part) – pages 113-117

- The center of the atom is the \_\_\_\_\_.
- Three basic parts of an atom: \_\_\_\_\_ with \_\_\_\_\_ charge  
\_\_\_\_\_ with \_\_\_\_\_ charge  
\_\_\_\_\_ with \_\_\_\_\_ charge
- The number of protons an atom has is called the \_\_\_\_\_.  
The number of protons serves the function of \_\_\_\_\_.
- An atom has a ZERO NET CHARGE. This means that \_\_\_\_\_.
- Since an atom has a zero net charge, the \_\_\_\_\_ charge must balance the \_\_\_\_\_ charge.
- In an atom, the numbers of \_\_\_\_\_ and \_\_\_\_\_ must be equal.
- The \_\_\_\_\_ has almost the same mass as the \_\_\_\_\_.
- Compared to other particles, the \_\_\_\_\_ has a mass that is much less than the others. We say that its mass is \_\_\_\_\_.
- Most of an atom is occupied by \_\_\_\_\_.
- The atomic number of an element is the number of \_\_\_\_\_. It is the same for any atom of a given element.
- The mass number of an element is the number of \_\_\_\_\_ plus the number of \_\_\_\_\_.
- Isotopes are atoms that have the same number of \_\_\_\_\_ (meaning they are the \_\_\_\_\_ element) but having different numbers of \_\_\_\_\_ (meaning they have different \_\_\_\_\_).

In writing ISOTOPE NOTATION, we include the elemental symbol, the atomic number, and the mass number.



- The  $A$  represents the \_\_\_\_\_ and is found by \_\_\_\_\_.
- The  $Z$  represents the \_\_\_\_\_ and is found by \_\_\_\_\_.
- The  $X$  represents the \_\_\_\_\_ and is found by \_\_\_\_\_.
- If you had the mass number and the atomic number, what would you do to find the number of neutrons?  
\_\_\_\_\_
- How big is an atom?

Given:



- What is the atomic number? \_\_\_\_\_
- What is the mass number? \_\_\_\_\_
- How many protons? \_\_\_\_\_
- How many electrons? \_\_\_\_\_
- How many neutrons? \_\_\_\_\_
- How else could this be written? \_\_\_\_\_
- The size (volume) of a given atom is determined by \_\_\_\_\_.
- The difference between the aluminum atom and the aluminum ion is . . .
- The phrase “nuclear charge” refers to . . .

## Chapter 5: Atomic Structure and the Periodic Table

### Part 1: Assignment – Introduction to Isotopes

Fill in the blanks with the appropriate data.

#	Name	${}^A_ZX$	Z	A	A/I?	Charge	p <sup>+</sup>	n <sup>o</sup>	e <sup>-</sup>
1		${}^{108}_{46}\text{Pd}^{+2}$							
2			74			+5		109	
3						+2		65	46
4	barium			138	ion				
5		${}^{123}_{51}\text{Sb}$			atom				
6			83	210					
7				26		+3			10
8					atom		43	56	
9	iodide			128					
10			34		ion			47	
11				125	ion		53		
12								18	15
13							54	79	
14				57		+3	26		
15	vanadium (II)							28	
16				39					19
17			89					138	
18				90			39		
19						+3		116	74
20			29	66					

21. Would you expect two electrons to attract or repel one another? Why?
22. What is the charge of the nucleus of every atom? What is this called?

## ***Chapter 5: Atomic Structure and the Periodic Table***

### ***Part 2: Notes – Atomic Theory and Its History***

**Objectives:** Identify, define, and explain: Dalton's atomic theory, atom, electrode, cathode ray tube,  $p^+$ ,  $n^0$ ,  $e^-$ , and nucleus.  
Outline the history of early atomic theory.  
State pertinent discovery relating to atomic theory's early history of: Democritus, Dalton, JJ Thomson, Millikan, Roentgen, Becquerel, Curie & Curie, Joliot & Curie, Rutherford, Geiger, and Chadwick.  
Explain and list the key points of Millikan's Oil Drop Experiment and Rutherford's Gold Foil Experiment.

**Text Reference:** Sections 5.1 and 5.2 – pages 106-112 and Section 13.1 (Part) 361-362.

**DEMOCRITUS -**

**JOHN DALTON –**

**WILLIAM CROOKES –**

**J. J. THOMSON –**

**ROBERT A. MILLIKAN –**

Using the charge of an electron from Millikan and the charge-to-mass ratio ( $e/m$ ) from Thomson, the mass of an electron was determined by various scientists at nearly the same time.

**WILLIAM ROENTGEN –**

**HENRI BECQUEREL –**

**MARIE AND PIERRE CURIE –**

**ERNEST RUTHERFORD –**

**HANS GEIGER –**

**IRENE CURIE-JOLIOT AND FREDERIC JOLIOT –**

**JAMES CHADWICK –**

After the discovery of the neutron, isotopes of various elements were discovered.

**Chapter 5: Atomic Structure and the Periodic Table**  
**Part 2: Assignment – Atomic Theory and Its History**

Fill in the blanks with the appropriate data.

#	Name	${}^A_ZX$	Z	A	A/I?	Charge	p <sup>+</sup>	n <sup>o</sup>	e <sup>-</sup>
1		${}^{55}_{26}\text{Fe}$			ion	+3			
2			45		atom			60	
3					atom			68	50
4	silicon			29	atom				
5			55	132	ion				

6. How are all atoms of the same element alike? How do atoms of the same element differ?
7. What parts of Dalton's atomic theory no longer agree with the current picture of the atom?
8. How could you modify Rutherford's experimental procedure to determine the relative sizes of different nuclei?
9. Rutherford's atomic theory proposed a small, dense nucleus surrounded by very small electrons. This implies that atoms are composed of mainly empty space. If all matter is mainly empty space, why is it impossible to walk through a wall?
10. This chapter illustrates the scientific method in action. What happens when new experimental results cannot be explained by existing theory?

11. The following table shows some of the data collected by Rutherford and his colleagues during their gold foil experiment.

- a. What percentage of the alpha particle deflections were 5° or less?
- b. What percentage of the alpha particle deflections were 15° or less?
- c. What percentage of the alpha particle deflections were 60° or greater?

Angle of deflection (°)	Number of deflections
5	8 289 000
10	502 570
15	120 570
30	7800
45	1435
60	477
75	211
>105	198

12. With which of these statements would John Dalton have agreed in the early 1800s? For each, explain why or why not.
  - a. Atoms are the smallest particles of matter.
  - b. The mass of an iron atom is different from the mass of a copper atom.
  - c. Every atoms of silver is identical to every other atom of silver.
  - d. A compound is composed of atoms of two or more different elements.

## Chapter 5: Atomic Structure and the Periodic Table

### Part 3: Notes – Calculating Atomic Mass

**Objectives:** Identify, define, and explain: atomic mass, fraction, atomic fraction, mass number, amu, and weighted average.  
Explain how isotopes differ and why atomic masses of elements are not whole numbers but mass numbers are.  
Calculate the average atomic masses of an element from isotope data.  
Differentiate between mass number and atomic number.  
Determine which isotope (of a pair) is most abundant based on the molar mass of the element.

**Text Reference:** Section 5.3 (Part) pages 118-121

First: What is a fraction?

How do you find a fraction of something?

We use percents and masses of individual isotopes to calculate the atomic mass of an element.

The formula is:

Atomic mass of element X = (mass A)(fraction of A) + (mass B)(fraction of B) + . . .  
(This is done for as many isotopes of the element as exist.)

**Example 1:** I have a sample of element *Andersonium*. It consists 18 atoms of isotope An-325, 45 atoms of isotope An-326, and 25 atoms of isotope An-328. The masses of the isotopes are as follows: An-325 is 324.9987 amu, An-326 is 325.9897 amu, and An-328 is 328.0102 amu. Calculate the atomic mass of the element Andersonium.

**Example 2:** There is a sample of the element chemium (Ch). The element chemium consists of 32.94% of the isotope Ch-340 (with a mass of 339.8998 amu), 43.53% of the isotope Ch-342 (with a mass of 342.0180 amu), and 23.53% of the isotope Ch-343 (with a mass of 3343.0074 amu). What is the atomic mass of chemium?

**Example 3:** There is a sample of terrerium. There are two isotopes of terrerium, Tr-463 with a mass of 462.9897 amu and Tr-465 with a mass of 465.0105 amu. If the atomic mass of terrerium is 464.1205, what is the percentage of each isotope of terrerium?

**Relationship between molar mass and atomic mass unit:**

## Chapter 5: Atomic Structure and the Periodic Table

### Part 3: Assignment – Calculating Atomic Mass

Answer the questions or solve the following problems. Show all work . . .

1. Element Q has three isotopes. It is 18.75% Q-318, 78.26% Q-319, and 2.99% Q-320. The masses of the isotopes are 317.9895 amu, 318.9875 amu, and 320.0265 amu, respectively. What is the molar mass of the element Q?
2. Element X consists of two isotopes, X-72 and X-73. The atomic mass of X-72 is 72.0093 amu and the atomic mass of X-73 is 72.9984 amu. The atomic mass of ordinary X is 72.3047 amu. What is the percent abundance of each isotope of X?
3. Element Z consists of two isotopes Z-84 and Z-86. the atomic mass of Z-84 is 83.9873 amu and the atomic mass of Z-86 is 85.9930 amu. The atomic mass of ordinary Z is 84.6324 amu. What are the percentages of the two isotopes?
4. Ordinary oxygen is a mixture of three isotopes: O-16 (mass of 15.9949 amu), O-17 (mass of 16.9994 amu), and O-18 (mass of 17.9992 amu). If their respective percent abundances are 99.76%, 0.04%, and 0.20%, what is the atomic mass of ordinary oxygen?
5. Explain why the atomic masses of elements are not generally whole numbers.
6. When the masses of the particles that make up an atom are added together, the sum is always less than the actual mass of the atom. The missing mass is called the *mass defect* and represents the mass converted into energy when the nucleus is formed from its component neutrons and protons. Calculate the mass defect of achlorine-35 atom; the actual mass of a chlorine-35 atom is  $5.81 \times 10^{-23}$  g. The mass of a proton is  $1.67 \times 10^{-24}$  g and the mass of an electron is  $9.11 \times 10^{-28}$  g.

## Chapter 5: Atomic Structure and the Periodic Table

### Part 4: Individual Assignment – Basics of Periodic Table

**Objectives:** Identify, define, and explain: periodic table, period, periodic law, group, representative element, metal, alkali metal, alkaline earth metal, transition metal, inner transition metal, nonmetal, halogen, noble gases, and metalloids.

Describe the origin of the periodic table.

Identify the position of groups, periods, and the transition metals in the periodic table.

Identify the location of metals, nonmetals, and metalloids on the periodic table.

**Text Reference:** Section 5.4 – pages 123-126

1. Read the pages listed in the above text reference; these pages relate to organizing the elements into the periodic table. These pages are especially helpful, but other pages may also be used. (You will need to use the index.)
2. On a **separate sheet of paper**, answer the following 12 questions **in complete sentences**. Be neat and complete!
3. Upon receipt of the blank periodic table grid from your instructor, complete the 14 directions that appear after the questions according to the specifications described.

After you have answered all questions and completed the directions, attach your periodic table to the questions and turn in.

This is all to be completed and ready to turn in at the start of class on \_\_\_\_\_.

#### Questions:

1. What is the periodic table and how is it arranged?
2. What is the periodic law?
3. In chemistry, what is a period? In chemistry, what is a group and what is another name for a “chemical” group.
4. What is atomic number?
5. In general, on what side of the periodic table are metals located and on what side are nonmetals located?
6. What is a diatomic molecule and what elements exist as diatomic molecules?
7. Why are the elements in the last column on the right called noble gasses?
8. Look up the word *periodic* in the dictionary. Propose a reason for naming for the periodic table.
9. How did Moseley’s arrangement of the elements differ from that of Mendeleev?
10. Give the symbol of each element requested.
  - a. the nonmetal in Group 4A
  - b. the inner transition metal with the lowest atomic number
  - c. all of the nonmetals for which the atomic number is a multiple of 5
  - d. the two elements that are liquid at are room temperature
  - e. the metal in Group 5A
11. Diamond and graphite are both composed of carbon atoms. The density of diamond is 3.52 g/mL while that of graphite is 2.25 g/mL. In 1955, scientists successfully made diamond from graphite. Using the relative densities, imagine what happens at the atomic level. Then suggest how this synthesis may have occurred.
12. Do you think there are more elements still to be discovered? Explain.

#### Directions:

For Directions 1 - 14, you are to follow the given directions and place your work on the blank periodic table grid you received. Be neat and clear. Follow the directions exactly as they are given.

1. Use a black pen to fill in the symbols of the elements with the following atomic numbers: 1–38, 47, 48, 50-56, 74, 78-80, 82, 83, 85-88, and 92. Write the symbol in the bottom half of the box, but do not take up the whole box. Refer to the periodic table in your book if necessary.
2. Find the periods on the periodic table. Place a number at the start of each period and draw a circle around the number.

3. Find the groups on the periodic table. Place a number at the start of each group and draw a square around the number.
4. Use a red pencil (or marker) to color the inside border (and only the border) of all the elements that form diatomic molecules.
5. Color the boxes of the elements in the halogen group with a red pencil.
6. Color the boxes of the elements in the noble gas group with a blue pencil.
7. Color the boxes of the elements in the alkali metal group with a green pencil.
8. Color the boxes of the elements in the alkaline earth metal group with an orange pencil.
9. Color the boxes of the elements in the transition metal section with a yellow pencil.
10. Color the boxes of the elements that are metalloids with a purple pencil.
11. Color the boxes of the elements that are inner transition metals with a brown pencil.
12. Identify the elements that are gases at room temperature. Place a black marker dot in the upper right corner of these elements.
13. Identify the elements that are liquids at room temperature. Place a red marker dot in the upper right corner of these elements.
14. Determine the charge of the ions formed by the elements in groups 1, 2, 13, 14, 15, 16, 17, and 18. Write the charge in the upper left corner of the box.