

**CHEMISTRY UNIT 3: ATOMIC STRUCTURE AND NUCLEAR CHEMISTRY**

*Broad Concept:* Atomic models are used to explain atoms and help us understand the interaction of elements and compounds observed on a macroscopic scale. Nuclear chemistry deals with radioactivity, nuclear processes, and nuclear properties. Nuclear reactions produce tremendous amounts of energy and the formation of the elements.

- 2.1 Recognize discoveries from Dalton (atomic theory), Thomson (the electron), Rutherford (the nucleus), and Bohr (planetary model of atom) and understand how these discoveries lead to the modern theory.
- 2.2 Describe Rutherford's "gold foil" experiment that led to the discovery of the nuclear atom. Identify the major components (protons, neutrons, and electrons) of the nuclear atom and explain how they interact.
- 2.3 Interpret and apply the laws of conservation of mass, constant composition (definite proportions), and multiple proportions.

**NOTEBOOK -TABLE OF CONTENTS**

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## Unit 3

Part 1

# "Atomic Structure Notes"

Model Timeline - Sketch each

[http://abyss.uoregon.edu/~js/21st\\_century\\_science/lectures/lec05.html](http://abyss.uoregon.edu/~js/21st_century_science/lectures/lec05.html) - picture

## Part 1. Defining the Atom

- OBJECTIVES: You will be able to
  - Describe Democritus's ideas about atoms.
  - Explain Dalton's atomic theory.
  - Identify what instrument is used to observe individual atoms.

# Notes: Defining the Atom

## A. Democritus



## B. Alchemists

What was alchemy?

What was really important about what the alchemists accomplished?

### C. Important Pre-Dalton Discoveries

- **William Gilbert:**
- **Benjamin Franklin -**
- **Charles Coulomb -**
- **Antoine Lavoisier -**
- **Joseph Proust -**

### D. Dalton's Discoveries

## Dalton's Atomic Theory (experiment based!)



John Dalton  
(1766 - 1844)

- 1) All elements are composed of tiny \_\_\_\_\_ particles called atoms
- 2) Atoms of the same element are \_\_\_\_\_. Atoms of any one element are \_\_\_\_\_ from those of any other element.
- 3) Atoms of different elements combine in simple \_\_\_\_\_ to form chemical compounds
- 4) In \_\_\_\_\_, atoms are combined, separated, or rearranged - but never changed into atoms of another element.

E. Video: Ludwig Boltzmann and the beginning of atomic theory

F. Video: Albert Einstein Proves the Existence of the Atom

## G. Sizing up the Atom

\_\_\_\_\_ into smaller and smaller particles - these are the \_\_\_\_\_, and they still have properties of that element

oIf you could line up 100,000,000 copper atoms in a single file, they would be approximately \_\_\_\_\_.

oDespite their \_\_\_\_\_, individual atoms are observable with instruments such as \_\_\_\_\_

\_\_\_\_\_



CHAPTER THREE, PART 1 - USE YOUR NOTES, NAME \_\_\_\_\_  
TEXT AND THE INTERNET TO ANSWER THE FOLLOWING. DATE \_\_\_\_\_

SECTION 3.1 ORIGINS OF THE ATOMIC THEORY: ANCIENT GREEK PHILOSOPHERS

1. In 440 B.C. in ancient Greece Leucippus and Democritus claimed that matter was made of atoms. What were the attributes of these atoms that they hypothesized about? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
2. This hypothesis about atoms was in conflict with another philosopher's ideas about matter. What did Aristotle think was true about matter? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
3. What is a good way to compare these two hypotheses? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
4. Did either philosophical hypothesis have any evidence for it at that time? What was it? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

FOUNDATIONS OF A MODERN ATOMIC THEORY

5. In 1785 someone finally collected the first necessary piece of evidence for the atomic theory of matter. Antoine Lavoisier performed experiments in which he carefully weighed all materials (including gases) before and after a chemical or physical change. What is the **Law of Conservation of Matter** which we now attribute to his work? How did he prove it? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

An essential advance required for the advancement of chemistry was the careful application of a very accurate balance to investigate chemical and physical changes in closed systems.

6. Explain how water was produced by early chemists from hydrogen and oxygen gases.  
\_\_\_\_\_  
\_\_\_\_\_
7. In 1797 a man named Joseph Louis Proust performed careful experiments investigating the elemental composition of compounds. He found that the ratio of the masses of the elements in a compound was always the same for that compound. Prior investigations of this kind had not been

made to as high a level of precision and led scientists to believe that elements could be in any ratio and still make the same compound. This result is now known as the **Law of Definite Proportions**. How is this law critical to the argument that matter is made of atoms? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

### Dalton's Atomic Theory

8. What is a scientific theory? \_\_\_\_\_  
\_\_\_\_\_
9. What makes a scientific theory different from an opinion (sometimes called a 'theory')? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
10. What is John Dalton's Atomic Theory (published in 1803)? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
  
11. How does Dalton's atomic theory explain the law of conservation of mass? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
12. How does Dalton's atomic theory explain the law of definite proportions? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
13. Dalton made a prediction about the ratios in which elements can combine. We call this prediction the **Law of Multiple Proportions**. What does it mean? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
14. Answer questions: page 71 #3 and page 89 #2 in class - blue Modern Chemistry text book.  
Online text its page 67 #3 and page 86 #2



# The Atom: From Philosophical Idea to Scientific Theory

## Section Review 3.1

#  
Hand-  
work

**DIRECTIONS:** Write on the line at the right of each statement the letter preceding the word or expression that best completes the statement.

- The schoolteacher who studied atoms and proposed an atomic theory was (a) John Dalton; (b) Jöns Berzelius; (c) Johann Dobereiner; (d) Dmitri Mendeleev. \_\_\_\_\_ 1
- According to Dalton's atomic theory, atoms (a) are destroyed in chemical reactions; (b) can be subdivided; (c) of a particular element are identical in size, mass, and other properties; (d) of different elements cannot combine. \_\_\_\_\_ 2
- One part of Dalton's atomic theory that has been modified is the idea that (a) all matter is composed of atoms; (b) atoms of different elements have different properties and masses; (c) atoms can combine in chemical reactions; (d) atoms cannot be subdivided. \_\_\_\_\_ 3
- Dalton's atomic theory did not explain (a) whole-number ratios; (b) definite proportions; (c) conservation of mass; (d) conservation of energy. \_\_\_\_\_ 4
- The law of definite composition (a) contradicted Dalton's atomic theory; (b) was explained by Dalton's atomic theory; (c) replaced the law of conservation of mass; (d) assumes that atoms of all elements are identical. \_\_\_\_\_ 5
- The fact that lead forms two oxides of different formulas, PbO and PbO<sub>2</sub>, is an example of the (a) periodic law; (b) law of multiple proportions; (c) atomic law; (d) law of conservation of mass. \_\_\_\_\_ 6

**DIRECTIONS:** Write on the line at the right of each statement the word or expression that best completes the meaning when substituted for the corresponding number.

- Water, H<sub>2</sub>O, has a mass ratio of oxygen to hydrogen of 8:1. Hydrogen peroxide, H<sub>2</sub>O<sub>2</sub>, has a mass ratio of oxygen to hydrogen of (7). \_\_\_\_\_ 7
- If 3 grams of element C combine with 8 grams of element D to form a compound CD, (8) grams of D are needed to form compound CD<sub>2</sub>. \_\_\_\_\_ 8
- Evidence in support of the law of (9) is that in oxides of nitrogen, such as N<sub>2</sub>O, NO, NO<sub>2</sub>, and N<sub>2</sub>O<sub>3</sub>, atoms combine in small whole-number ratios. \_\_\_\_\_ 9
- (10) is the person credited with being the first to recognize that the relative number of atoms that combine are proportional to the masses that combine. \_\_\_\_\_ 10
- An example of the law of (11) is the fact that the mass ratio of two elements in a compound is constant. \_\_\_\_\_ 11
- If atoms of element D weigh three mass units and atoms of element E weigh nine mass units, a chemical compound composed of one atom each of D and E will weigh (12) mass units. \_\_\_\_\_ 12
- If 2 grams of element A combine with 10 grams of element B, then 12 grams of element A will combine with (13) grams of element B. \_\_\_\_\_ 13

**DIRECTIONS:** Write the answers to the following on the lines provided.

- State the law of multiple proportions. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ 14
- State the two main ideas of Dalton's atomic theory that have remain unchanged since he first proposed his theory. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ 15