LIFEPAC®

SCIENCE

STUDENT BOOK

11th Grade | Unit 4

Alpha Omega
PUBLICATIONS

SCIENCE 1104

ATOMIC STRUCTURE AND PERIODICITY

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ATOMIC STRUCTURE AND PERIODICITY

Introduction

Genesis 1:1 states: "In the beginning God created the heavens and the earth." What does this verse mean? Dr. Alfred M. Rehwinkel in his book, *The Wonders of Creation*, gives us his explanation.

> In view of what occurred on the six days of the creation week, the heaven and the earth in this connection can only mean that on the first day God began by the creation of matter out of which He formed the things that were made on the days that followed. God began the creation by first providing himself with the material out of which all other things were formed. Matter is not eternal, as the ancient Greek philosophers and the modern evolutionists assume. Matter had its beginning with God; He created it out of nothing; We first filled the absolute vacuum of nothingness with raw, unsystematized matter. There is no other possible source for the origin of matter. Dead matter could not have created itself.
>
> But that raises the next important question: namely, What is matter? What is the essence of the substance out of which heaven and earth were made?
>
> On the one hand, matter might be defined as a combination of a number of chemical substances which combined according to very specific laws to form that something which we call matter, but that leads to the next question: that is, What is the origin of the individual chemical substances which are combined to form matter? How did the laws come into being which cause them to combine in a given order? Science has isolated over a hundred separate substances which are basic or simple and do not consist of combinations of other substances, but how did they come to be just what they are? Why is gold gold, and silver silver, and uranium uranium, and why are all the other isolated elements what they are and why are they separated from one another? Why are they found where they are found and what accounts for their peculiar qualities?
>
> Scientists thought they had succeeded in breaking down matter to its last ultimate unit: that is, the atom. In an article which appeared in a national magazine, a writer on this subject was introduced by the editor of that magazine as "one of the nation's foremost interpreters of modern science." This modern authority on science then wrote that the Greeks knew the atom but they did not know what we know about the atom nor of its infinite smallness. Then this writer continues by making a startling statement asserting that a teaspoonful of water contains a million billion trillion atoms. We can repeat these figures, but no one can comprehend what they mean. And this writer then says, "We now have learned that this infinitely tiny atom is composed of still smaller parts which form a microscopic universe in which there is action, energy and motion similar to that of our own solar system."
>
> In everyday language we speak of dead matter, and, of course, it is dead in the sense that it does not have in it what we call the germ of life, nor can it propagate itself. But it is not dead in the sense that it is inactive or absolutely static. In a lump of so-called dead matter, there are countless billions of atoms, each one an active universe, a bundle of energy and force beyond all comprehension, as we have learned since the atomic bomb has come into existence.[1]

This LIFEPAC® will guide our exploration of the history of atomic theory and develop some ideas about our modern model of the atom.

Objectives

Read these objectives. The objectives tell you what you will be able to do when you have successfully completed this LIFEPAC. When you have finished this LIFEPAC, you should be able to:

1. Develop a time-event sequence leading to our present atomic model.
2. Identify eight key scientists and explain their contributions to atomic theory.
3. Develop the theory of modern atomic structure.
4. Develop and explain the periodicity of atomic structure.
5. Explain nuclear reactions.

[1]Rehwinkel, Alfred M. *The Wonders of Creation*; Bethany Fellowship, Inc. Minneapolis, Minnesota, 1974, pages 50-51.

Survey the LIFEPAC. Ask yourself some questions about this study and write your questions here.

1. CONTRIBUTORS TO A CONCEPT

This section is designed to help you get a better idea and appreciation for eight scientists who made great contributions to the development of our present-day atomic theory. Information on each scientist was taken from the "Atomic Pioneer Series" published by the United States Energy Research and Development Administration.

Section Objectives

Review these objectives. When you have completed this section, you should be able to:

1. Develop a time-event sequence leading to our present atomic model.
2. Identify eight key scientists and explain their contributions to atomic theory.
   - 2.1 Identify and locate the three main particles of atoms.
   - 2.2 Use the atomic mass and atomic numbers of the different elements.

Vocabulary

Study these words to enhance your learning success in this section.

alpha particle	**atomic mass**	**atomic number**	**beta particle**
electrons	**gamma**	**ion**	**isotopes**
neutrons	**nucleus**	**protons**	**quantum**
radioactive	**spectrum**		

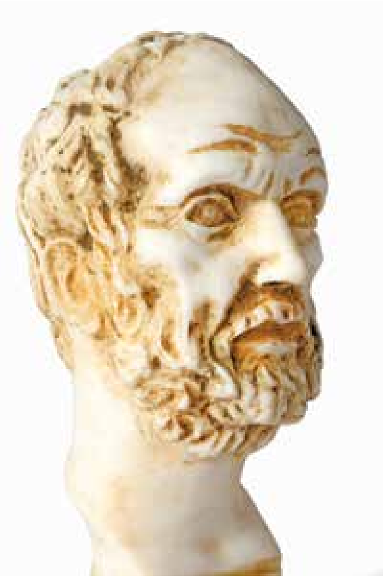
Note: *All vocabulary words in this LIFEPAC appear in* **boldface** *print the first time they are used. If you are not sure of the meaning when you are reading, study the definitions given.*

DEMOCRITUS

Democritus was the world's first great atomic philosopher. He was born in Abdera, Thrace, around 460 B.C. and died, place unknown, about 380 B.C.

Biographical details. After studying under Leucippus in Abdera, Democritus resolved to spend his inheritance in research abroad. He traveled widely, studying in Egypt for five years and then journeying to Chaldea, Babylon, Persia, and possibly to India.

Democritus was interested in all branches of knowledge and specialized in mathematics, astronomy, and medicine. He lived in the shadow of another Greek philosopher, Socrates. Democritus once visited Athens and saw Socrates, but he was too shy to introduce himself.



| Democritus

He wrote many books, but they did not survive. We know of them because of references made to them by other writers. His interest in ethics led him to write proverbs, the accumulated wisdom of his people. He was a cheerful lover of knowledge, and he lived to the age of eighty.

Scientific achievements. For Democritus, the world was made of only two things: the vacuum of empty space and the fullness of matter. All matter consisted of particles so small that nothing smaller could be imagined.

These particles were indivisible. The word *atom* itself means *that which cannot be cut*. These atoms were eternal, unchangeable, and indestructible. They differed from each other in physical shape, and this difference allowed them to form different substances.

Democritus's theory of atoms led him to expound an explanation of the world that was completely mechanical. He reasoned that no such thing as spirit existed apart from matter. He postulated special "soul" atoms. The universe was the blind result of swirling atoms. Through their motions these atoms clumped together to form worlds.

Contribution to atomic science. Although long overshadowed by Socrates, his contemporary, Democritus nevertheless was the most successful of the Greek philosopher-scientists in the correctness of his theories.

In line with the Greek basis of knowledge, his ideas were derived from deductive reasoning, not from experimenting and testing. Yet his view of the world was much closer to our modern concepts than the views of most other Greek philosophers of that time.

Answer these questions.

1.1 Who was the first to propose the idea of atoms? ________________________________

1.2 In what century was the concept of atoms first proposed? ________________________

1.3 What was Democritus's academic preparation? ______________________________________

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1.4 How did Democritus account for differences in matter? ______________________________

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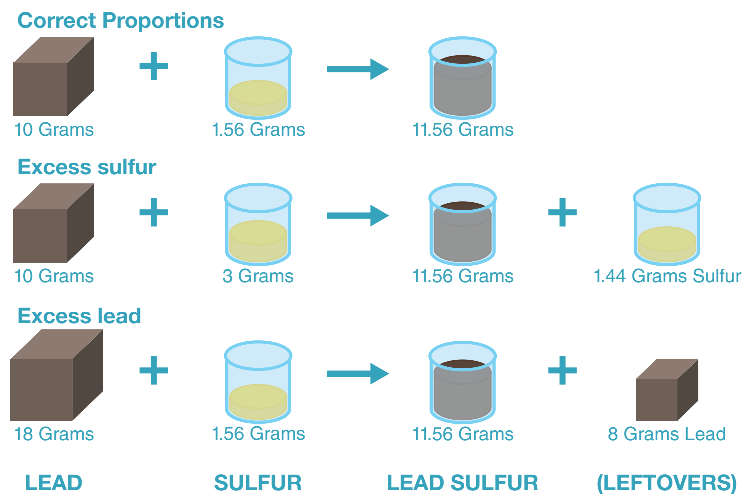
1.5 Who was Democritus's famous contemporary? ______________________________________



| Figure 1: The Law of Definite Proportions states that when excess reactants are used, the excess is not combined and becomes "leftovers."

JOHN DALTON

John Dalton, an English chemist, was born in Eaglesfield, Cumberland, England, on September 6, 1766, and died in Manchester on July 27, 1844. He is considered the father of modern atomic theory.

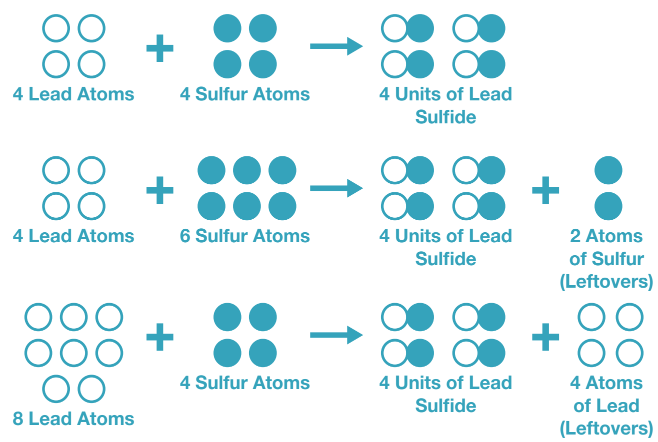
Biographical details. Dalton was the son of a poor weaver. His parents were Quakers (Society of Friends) and he was a devout member of that faith.

He received his early education from his father and at a Quaker school in his hometown. When his teacher retired, Dalton replaced him. He was then twelve years old.

He remained a teacher most of his life. When he was twenty-seven, he moved to Manchester and taught college until the college was moved. He then became both a public and private teacher of mathematics and chemistry, and he worked in his laboratory when he was not teaching.

Scientific achievements. Dalton's first scientific work was in meteorology. He kept weather records for fifty-seven years. He wrote a book about weather when he was twenty-seven years old. In his work, Dalton deduced that gases were composed of particles of matter, just as he thought solids were. He also made the first study of color blindness, a subject of personal interest since he himself was color blind.

His lasting work was in the field of atomic chemistry. He studied Newton and Boyle and experimented with gases and Proust's Law of Definite Proportions.



| Figure 2: The Law of Definite Proportions Interpreted in Terms of Dalton's Atomic Symbols

The Law of Definite Proportions states that substances combine in predictable proportions. When excess reactants are used, the excess becomes leftovers.

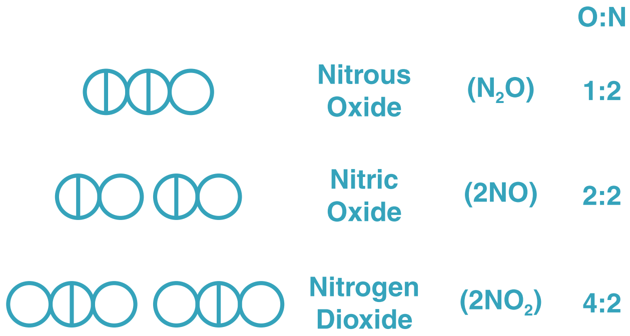
He formulated his own law of multiple proportions in 1803, based on his observation that the same elements combine in different proportions to produce different substances.

He proposed his atomic theory and published his ideas in a book, *New Systems of Chemical Philosophy* in 1808. He maintained that all matter is made of invisible atoms, that atoms are alike in everything except their mass (or weight), that in chemical reactions atoms preserve their identity and are not destroyed, and that only whole atoms may combine.

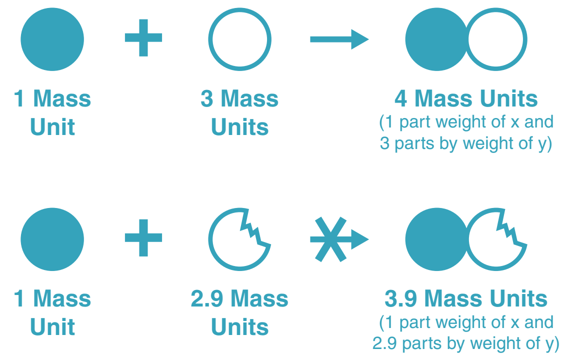
He tried to work out the relative masses of atoms; but his calculations were wrong, although the principle was correct. He was, however, the first to establish a table of **atomic masses**, with hydrogen, the lightest atom, as the standard.

Contribution to atomic science. Dalton occupies an important place in the history of atomic hypothesis from Democritus and Newton to his own day, primarily because he based his theory on scientific observation rather than on philosophical speculation.

After Dalton's work was published, it was widely accepted in a short time and eventually his atomic theory became the basis of all chemistry.



| Figure 3: The Law of Multiple Proportions



| Figure 4: According to Dalton's atomic theory, only whole atoms may combine. The second scheme is not possible.

Answer this question.

1.6 Who is considered the father of atomic theory? ______________________

Explain these concepts.

1.7 Law of Multiple Proportions ______________________

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____

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1.8 Law of Definite Proportions ______________________

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1.9 Dalton's model of the atom ______________________

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Try this experiment.

These supplies are needed:

- 9 samples of pure elements (sulfur powder, zinc powder, magnesium ribbon, iron, copper, lead, silver, etc.)
- reference textbook, a chemistry handbook, or online resources
- Science LIFEPAC 1103

Follow these directions and record your data in the table. Place a check in the box when the step is completed.

☐ 1. Get some samples of pure elements from the shelf or from your teacher.

☐ 2. From the observations you can make of the samples and with the use of a handbook, reference text, online resources, and Science LIFEPAC 1103, complete the following chart of properties.

Data Table 1

Element	Symbol	Physical State at 25°C	Color	Magnetic Yes or No	Atomic Mass	Other Properties

CHECK ____________________ ____________________

Teacher Date

Properties of Elements Experiment

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