LIFEPAC®

SCIENCE

STUDENT BOOK

6th Grade | Unit 5

Alpha Omega
PUBLICATIONS

SCIENCE 605
Chemical Structure

LIFEPAC Test is located in the center of the booklet. Please remove before starting the unit.

Author:
Barry G. Burrus, B.S., M.A., M.Div.

Editors:
Alpha Omega Staff

Illustrations:
Brian Ring/Alpha Omega Staff

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804 N. 2nd Ave. E.
Rock Rapids, IA 51246-1759

Chemical Structure

Introduction

God has created all things that we see in our universe. The substance of all things in our universe is called **matter**. All matter consists of many different kinds of substances called **chemicals**. Chemicals make all the substances that you see around you every day. In fact, your body is made up of many different kinds of chemicals.

In this LIFEPAC® you will learn about the *structure* of chemicals. All matter contains tiny particles that make its basic structure. This structure of matter forms the basic building blocks of all chemicals. God has designed matter and chemicals with marvelous order. Human beings have discovered much about the orderly structure of matter. You will learn about some ways that people have arranged these chemicals in charts and tables. One of these, the Periodic Table, is very helpful in understanding the structure and properties of chemicals.

Finally, chemicals *change* by combining with other chemicals. They also change from solid *state* to liquid to gas. You will learn more about chemical changes in this LIFEPAC.

Objectives

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

1. Define and give examples of matter and chemicals.
2. Describe and give examples of the different states of matter.
3. Define and describe atoms, molecules, elements, and compounds.
4. Identify the symbols of some common elements.
5. Name some chemical elements from the Periodic Table.
6. Identify and explain the atomic number, atomic weight, and symbols of chemicals.
7. Categorize certain elements such as metals, nonmetals, radioactive substances, and rare earth elements.
8. Write the chemical formulas for some compounds.
9. Identify acids and bases.

1. CHEMICAL STRUCTURE

In the beginning, God created everything that exists (Genesis 1). Everything in our physical universe is called **matter**. Matter is made of a great variety of substances called **chemicals**. The scientific study of substances and chemicals is called *chemistry*, and the scientists who study chemicals are called *chemists*. Chemistry is a very interesting subject. It permits us to see God's wonderful design of the basic structure of matter in all things that exist.

All matter in the universe occupies space. It also has an amount. The amount of matter in a thing is called its **mass**. Therefore, matter can be defined as anything that occupies space and has mass. Much of the matter around you can be seen. For example, your clothes, your books, and your desk are all types of matter that you can see. Some matter cannot be seen. You cannot see the air around you, but it is there. Air is matter. It has mass and occupies space. However, air is matter that is in the **gaseous** state. In this section of the LIFEPAC, you will learn more about matter in its three basic forms or states: solid, liquid, and gas.

The substances that build matter are called *chemicals*. All chemicals consist of tiny, basic building blocks. They are the basic "stuff " of all chemicals and matter. In this section of the LIFEPAC, you will learn more about these tiny units of matter and their basic structure. This will help you understand the basic structure of the chemicals that God has created.

Section Objectives

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

1. Define and give examples of matter and chemicals.
2. Describe and give examples of the different states of matter.
3. Define and describe atoms, molecules, elements, and compounds.

Vocabulary

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

atom (at əm). The small particle that makes up molecules. Each atom is unique for a chemical element.

chemical (kem ə kəl). Any of the many substances that make up the matter of the universe.

compound (kom pound). A substance whose molecules consist of atoms that are chemically united.

compress (kəm pres). Squeeze together; make smaller by pressure.

electron (i lek tron). An elementary particle of an atom which has a negative electrical charge.

element (el ə mənt). A pure substance that cannot be broken down into simpler substances by chemical means.

gaseous (gas ē əs). In the form of gas; of or like a gas.

mass (mas). The amount of matter in a body or object, usually measured in units like grams or pounds mass.

matter (mat ər). Anything which has mass and occupies space.

molecule (mol ə kyül). The chemical combination of two or more atoms.

neutron (nü´tron). An uncharged elemetary particle found in the nucleus of an atom.

proton (prō´ton). An elementary particle carrying a positive electrical charge which is located in the nucleus of an atom.

swarm (swôrm). Fly or move about in great numbers.

weight (wāt). The measurement of the pull of gravity on an object or body. On earth, mass and weight would be the same.

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.*

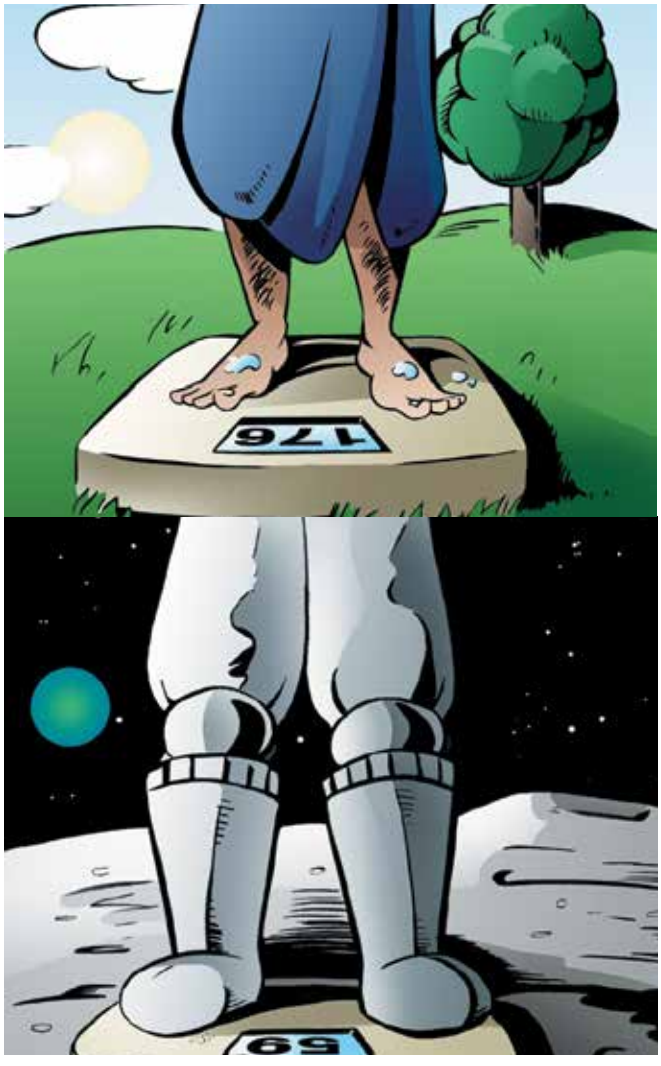
Pronunciation Key: h**a**t, **ā**ge, c**ã**re, f**ä**r; l**e**t, **ē**qual, t**ė**rm; **i**t, **ī**ce; h**o**t, **ō**pen, **ô**rder; **oi**l; **ou**t; c**u**p, p**u̇**t, r**ü**le; **ch**ild; lo**ng**; **th**in; /ŦH/ for **th**en; /zh/ for mea**s**ure; /u/ or /ə/ represents /a/ in **a**bout, /e/ in take**n**, /i/ in penc**i**l, /o/ in lem**o**n, and /u/ in circ**u**s.

MASS, WEIGHT, AND STATES OF MATTER

As a useful background to exploring chemical structure, it is helpful to examine the relationship between the *mass* of an object and its **weight**. In addition, it is also helpful to explore the three basic **states of matter** in which we find all chemicals: solid, liquid, and gas.

Mass and weight. One of the general properties of all matter and chemicals is *mass*, the *amount* of matter contained in an object. Mass should not be confused with an object's *weight*. The weight of an object of a given mass is directly related to the gravitational pull on the object. Therefore, an object's weight can change depending upon the pull of gravity on the object. Since the force of gravity decreases as one moves away from earth, the weight of the object would also decrease as one moves away from earth. For example, a person with a mass of 75 pounds (mass) would weigh 75 pounds (force) on earth; however, that person would weigh very little in outer space. That same person would weigh about 12 pounds (force) on the moon because the force of gravity on the moon is about 1/6 that on earth. However, the person would still have the same mass — 75 pounds (mass) — whether on the earth, in outer space, or on the moon.

The variations of gravitational pull of objects on earth change very little as the objects change altitude on earth. Therefore, for all practical



| Weight varies with gravity, but mass remains the same

purposes, the measurement of an object's weight *on earth* is the same as its mass.

States of matter. Matter in the universe is normally found in three different forms or *states*: solid, liquid, and gas. These three states are easy to identify. Water is a common example of matter in three different states. Solid water is the ice found in your freezer and other cold places. Liquid water is the normal state of water on earth and is the form that you drink from a glass. Water, as a gas, is found as steam that is heated on your stove. In addition, water vapor (gas) is found in the atmosphere from the evaporation of earth's oceans, lakes, and rivers. Let's briefly examine a little more about solids, liquids, and gases.

A *solid* has a specific shape and a fixed volume. For example, a block of wood has a fixed volume. A solid block of wood occupies a specific volume and has a definite shape. If you move the block of wood to another location, or if you place it in a different container, the block of wood would still have the same shape and occupy the same volume of space. If you squeezed the block of wood, it would still keep the same shape and volume.

A *liquid* has no fixed shape. It takes the shape of its container. However, a liquid does have a fixed volume. If you have a pint of water in a glass, its volume is one pint and its shape is the same as the glass it fills. If you pour this water into a bowl, its volume will still be one pint.

| Ice is a solid

| Steam (water vapor) is a gas

However, its shape will change to the shape of the bowl that it is in. If a liquid is squeezed, the volume will not normally change. If the volume of a liquid does change under very high pressure, the change will be by such a tiny amount that the volume can be considered the same.

A *gas* has no fixed shape of its own. It takes the shape of its container. Also, a gas does not have a fixed volume. A gas will expand if it enters a larger container, or it can be **compressed** or squeezed into a smaller container by increasing pressure.

| Water is a liquid

View 605 States of Matter, from the Grade 6 SCIENCE EXPERIMENTS Video

Try this experiment to learn about states of matter.

Overview. You will examine some common items about you in a home or classroom to determine properties of a solid, a liquid, and a gas.

These supplies are needed:

- a balloon
- a small block of wood (or a rock)
- a clean, square, plastic refrigerator dish
- a soda pop (save it to drink)

Follow these directions. Place a check mark in the box as you complete each step, and answer the questions as they are presented.

☐ 1. Identify some of the things in your room. Try to find a solid, a liquid, and a gas. Write their names in the spaces below.

1.1 a. Solid: _____

b. Liquid: _____

c. Gas: _____

☐ 2. Blow up a balloon. Squeeze it gently.

1.2 Is the statement true that a gas changes to take the shape of its container?

☐ 3. Examine the soda pop container before opening it.

1.3 Does the liquid take on the round shape of the bottle or can? _____

☐ 4. Open the soda pop. Pour the liquid into the square refrigerator dish.

1.4 Does the liquid take on the shape of the container? _____

☐ 5. Observe the bubbles of fizz which come to the top of the liquid soda pop. This fizz is due to the carbon dioxide gas which is dissolved into the drink. This is why it is called a "carbonated drink." Note carefully that the bubbles of the carbon dioxide gas leave the soda pop.

1.5 Does the carbon dioxide gas have a definite shape and volume, or does it take on the shape and volume of the container? _____

☐ 6. Examine the piece of wood.

1.6 Does the wood have a fixed shape and volume? _____

_____

_____

Experiment 605.A States of Matter

Write the correct letter and answer in each blank.

1.7 Air is matter that is in the _____ state.
a. gaseous b. convertible c. solid

1.8 All matter consists of many different kinds of substances called _____ .
a. photons b. chemicals c. neurons

1.9 Matter is material that takes up space and has _____ .
a. weight b. volume c. mass

1.10 Your weight on the moon would be _____ it is on the earth.
a. greater than b. less than c. the same as

1.11 Your mass on the moon would be _____ it is on the earth.
a. greater than b. less than c. the same as

1.12 A liquid _____ .
a. has a fixed volume but takes the shape of its container
b. has the volume and shape of its container
c. has a fixed volume and shape.

1.13 A gas _____ .
a. has a fixed volume but takes the shape of its container
b. has the volume and shape of its container
c. has a fixed volume and shape.

1.14 A solid _____ .
a. has a fixed volume but takes the shape of its container
b. has the volume and shape of its container
c. has a fixed volume and shape.

TEACHER CHECK _____ initials _____ date

CHEMICAL ELEMENTS AND ATOMS

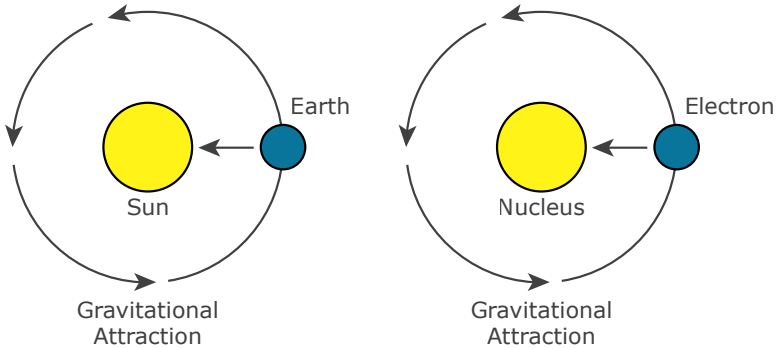
All matter and chemicals are composed of the most basic substances called **elements**. There are ninety-two elements that occur naturally on earth. An additional twenty-six elements have been identified and believed to exist. Twenty-three of these were produced in labs and in nuclear reactions due to the efforts of scientists. The other three exist only in theory and don't even have names yet. When those three are proven to exist and receive names, there will be 118. You will learn more about the names and classifications of elements in Section Two of this LIFEPAC.

Elements and atoms. Robert Boyle (1627-1691) was an Irish scientist who lived most of his life in England. He is considered to be the founder of modern chemistry. Boyle introduced many new methods for determining the identity and chemical composition of substances. He also disproved a long-held theory that air, earth, fire, and water were the basic parts of all matter. Rather, Boyle suggested the idea of many *elements* that compose matter. Boyle defined the word *element* as *a pure substance that cannot be broken down by chemical means*. For example, copper, gold, hydrogen, carbon, and oxygen are examples of well-known elements. These elements cannot be broken down into simpler substances by chemical means.

Boyle also suggested that all basic physical properties of matter and the elements were due to very tiny particles which were in motion. These tiny particles of elements are known as **atoms**. Atoms are the smallest part of an element that can exist as that element. Pure elements are made up of atoms of that element. For example, copper is made of copper atoms, gold is made of gold atoms, and carbon is made of carbon atoms. The atoms of each element are unique to that element. Atoms are the basic building blocks of all matter.

Atoms are very, very tiny. They are more than a million times smaller than the thickness of a human hair! Atoms are so small that they cannot be seen, even with the most powerful microscopes. However, the presence of atoms can be verified by x-rays and by chemical reactions.

Parts of an atom. Even though atoms are so tiny, they consists of even smaller particles! These tiny particles that make up atoms are called *subatomic particles*. There are three basic types of subatomic particles: **protons**, **neutrons**, and **electrons**. Each atom of each chemical element has a definite and unique number of these subatomic particles. Located at the center of each atom is the *nucleus*. The protons and neutrons are located in the nucleus. The rest of the atom outside the nucleus is



| The planetary model of an atom

mostly empty space. The electrons travel about through this empty space at incredible speeds! The electrons complete billions of trips around the nucleus in a millionth of a second!

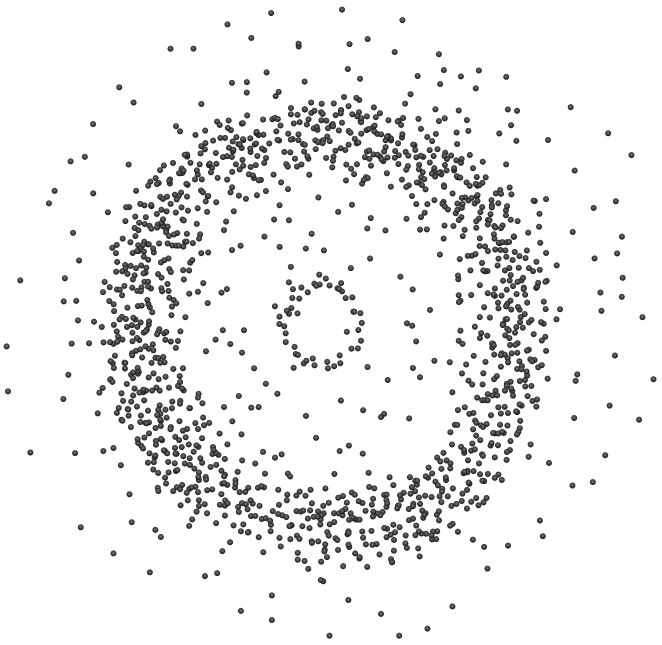
Models of atoms. A model is something that attempts to show or explain how something looks or acts. Several models have been proposed that attempt to show or explain how the subatomic particles of an atom operate.

One of the first models of an atom that was developed is called the *planetary model*. It is also called the *Bohr model*, named after Niels Bohr (1885-1962), a Danish scientist who developed a theory about the structure of an atom. The planetary model (or Bohr model) is based on the appearance of our sun with the planets of our solar system in orbit around the sun. In this case, the nucleus of the atom would correspond with the sun and the electrons would correspond with the planets that orbit the sun. However, this model is not completely accurate. Unlike the planets orbiting around the sun, the electrons in an atom do not follow regular, orderly paths. In addition, the protons and neutrons in the nucleus constantly move around at random. However, this model is still used today because it is simple and easy to draw.

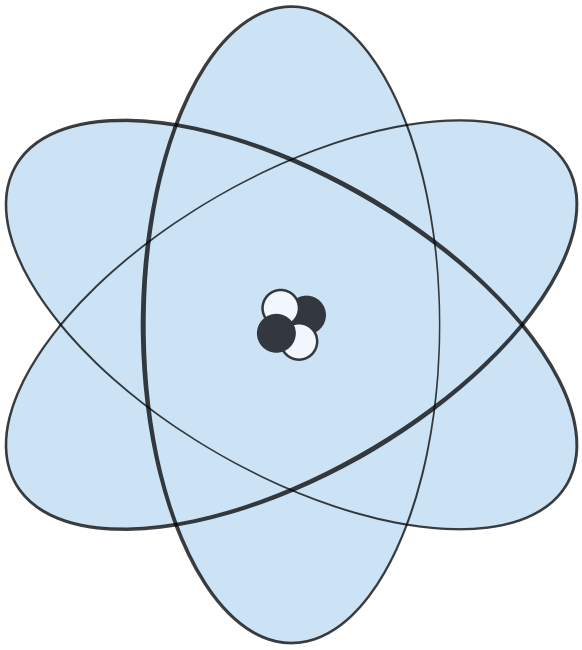
Another model of the atom is called the *electron cloud model*. This model shows better the probability that an electron is at a given point at a given time. It shows that the electrons actually **swarm** about the nucleus in an incredibly fast way. However, the electron cloud model is very hard to draw!

Still another model of the atom can be called the *simplified model*. It attempts to simplify the positions of the electrons. This model helps to show how the electrons move around the nucleus, and it is much easier to draw than the electron cloud model.

Perhaps none of these models are really correct, but they do attempt to show and explain how the electrons move about the nucleus of an atom.



| The electron cloud model



| The simplified model

Match the following items.

1.15 _____ elements

1.16 _____ naturally occurring elements

1.17 _____ founder of modern chemistry

1.18 _____ atoms

1.19 _____ protons, neutrons

1.20 _____ electrons

a. Robert Boyle

b. Niels Bohr

c. tiny parts of elements

d. most basic pure substances

e. twenty six

f. ninety two

g. subatomic particles that swarm about the nucleus

h. subatomic particles of the nucleus

Do the following activities.

1.21 List three different models of the atom and briefly describe what each attempts to show.

a. _____

_____

_____

b. _____

_____

_____

c. _____

_____

_____

1.22 In the space below, draw an example of an atom with one electron using the planetary model (Bohr model). Label the parts of the drawing.

SELF TEST 1

Answer true or false (each answer, 2 points).

1.01 _____ All matter in the Universe consists of many substances called elements.

1.02 _____ A chemical is always the same thing as an element.

1.03 _____ Chemicals can change by combining with other chemicals.

1.04 _____ Scientists who study the science of substances are called geologists.

1.05 _____ Air is not matter because you cannot see it.

1.06 _____ On earth, the mass of an object is almost exactly the same as its weight.

1.07 _____ A solid has a specific shape and a fixed weight.

1.08 _____ The tiny particles of elements are called atoms.

1.09 _____ A molecule may contain two atoms of the same element.

1.010 _____ Electrons are located in the nucleus of an atom.

Match the following items (each answer, 3 points).

1.011 _____ H_2O

1.012 _____ NaCl

1.013 _____ CO_2

1.014 _____ compound

1.015 _____ elements

1.016 _____ atoms

1.017 _____ naturally occurring elements

1.018 _____ simplified model

1.019 _____ gas

1.020 _____ weight

a. most basic pure substances

b. ninety-two

c. carbon dioxide

d. salt

e. water

f. copper oxide

g. measures gravitational pull

h. combined atoms are different

i. tiny particles of elements

j. shows structure of atoms

k. no fixed shape or volume

l. the amount of matter

Write the correct letter and answer in each blank space (each answer, 2 points).

1.021 Matter is material that takes up space and has _____ .

a. weight b. volume c. mass

1.022 The mass on the moon would be _____ it is on the earth.

a. greater than b. less than c. the same as

1.023 A liquid _____ .

a. has a fixed volume but takes the shape of its container
b. has the volume and shape of its container
c. has a fixed volume and shape

1.024 A gas _____ .

a. has a fixed volume but takes the shape of its container
b. has the volume and shape of its container
c. has a fixed volume and shape

1.025 A solid _____ .

a. has a fixed volume but takes the shape of its container
b. has the volume and shape of its container
c. has a fixed volume and shape

1.026 The scientist who said matter was made of many elements and is considered the founder of modern chemistry was _____ .

a. Niels Bohr b. Francis Bacon c. Robert Boyle

1.027 The tiny particles that make up atoms are called _____ .

a. compounds b. subatomic particles c. enzymes

1.028 The total number of elements that have been identified is _____ .

a. 92 b. 118 c. 126

1.029 When carbon dioxide is bubbled through limewater, _____ is formed.

a. carbon lime b. sodium chloride c. calcium carbonate

1.030 Atoms are more than _____ times smaller than the thickness of human hair.

a. a million b. ten thousand c. a thousand

Create drawings with labels of electron(s) and nucleus (each drawing, 5 points).

1.031 In the space below, draw an example of an atom using the *planetary model*.

1.032 In the space below, draw an example of an atom using the *simplified model*.

Write *yes* **or** *no* **on each blank line** (each answer, 2 points).

1.033 Is copper oxide a(n):

a. atom? _____

b. molecule? _____

c. subatomic particle? _____

d. element? _____

e. compound? _____

Answer the following questions (each answer, 5 points).

1.034 What is the *electron cloud model* and what does it attempt to show?

_____

_____

1.035 What is the definition of an *element*?

_____

_____

80/100 **SCORE** _____ **TEACHER** _____ _____
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Alpha Omega
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800-622-3070
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