LIFEPAC®

SCIENCE

STUDENT BOOK

9th Grade | Unit 1

Alpha Omega
PUBLICATIONS

SCIENCE 901
Our Atomic World

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

Author:
Harold Wengert, Ed.D.

Editor:
Richard W. Wheeler, M.A.Ed
Consulting Editor:
Rudolph Moore, Ph.D.
Revision Editor:
Alan Christopherson, M.S

Westover Studios Design Team:
Phillip Pettet, Creative Lead
Teresa Davis, DTP Lead
Nick Castro
Andi Graham
Jerry Wingo
Don Lechner

Alpha Omega
PUBLICATIONS

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

Our Atomic World

Introduction

We have already studied much about the world around us. Our entire study of science is our study of God's creation and how we can be better stewards of His planet. We can be good gardeners and caretakers only if we know all about the plants we are growing: how to fertilize, prune, water, and protect the plants from insects and disease. The more we study and know about these plants, the better we will be able to care for them and help them grow healthy and productive. Similarly, the more we know about the marvelous creation God has entrusted to us, the better we can care for it, protect it, and benefit from it.

This LIFEPAC® will help us to review some basic ideas about the planet and universe, what makes up matter, how it is found in its natural state, and some models of how this matter is made and held together.

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. Describe the three phases of matter.
2. List and describe the three major particles making up the atom.
3. Describe, draw, and label the basic structure of simple atoms.
4. Explain radioactivity, detection, and measurement.
5. Describe the atomic nucleus.
6. Describe fission and fusion reactions.
7. State Enrico Fermi's contribution to science.
8. Describe the components of a nuclear reactor.
9. Describe several uses for nuclear energy.
10. Outline some advantages and disadvantages of nuclear energy.

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

1. STRUCTURE OF MATTER

The first book of the Bible clearly outlines the source of all matter (Genesis 1:1): "In the beginning God created the heaven and the earth." Every particle of matter was created at that time. The rest of creation involved just the rearranging and formation of new things from the "stuff" He had already made. Let's review some things we have already learned about matter; the "stuff" of His creation.

SECTION OBJECTIVES

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

1. Describe the three phases of matter.
2. List and describe the three major particles making up the atom.
3. Describe, draw, and label the basic structure of simple atoms.

VOCABULARY

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

atom (at´ um). The smallest particle of matter still retaining the characteristics of the element; building block of matter.

atomic number (u tom´ ik num´ bur). The number of protons in an atom; the number which identifies an element.

electron (i lek´ tron). A tiny particle with a negative electrical charge; it circles the nucleus and has 1/2,000 the mass of a proton or neutron.

element (el´ u munt). The class of matter in which there are 106 different varieties.

neutron (nü´ tron). The neutral or no charge particle of an atom; it is located in the nucleus; has the same mass as the proton.

nucleus (nü ´klē us). The center of the atom.

proton (prō´ ton). A particle in the nucleus of an atom; it has a positive electrical charge and is 2,000 times the mass of the electron; the number of protons equals the atomic number.

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**ă**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**u**t, r**ü**le; **ch**ild; lo**ng**; **th**in; /*ŦH*/ for **th**en; /*zh*/ for mea**s**ure; /*u*/ represents /*a*/ in **a**bout, /*e*/ in tak**e**n, /*i*/ in penc**i**l, /*o*/ in lem**o**n, and /*u*/ in circ**u**s.

PHASES OF MATTER

Usually matter is found naturally in one of three states or phases. The phases are *solid, liquid*, or *gas.* The temperature of the substance determines its phase. For example, if water is put in a freezer, it becomes a solid. If frozen water (ice) sits out at room temperature, it melts into a liquid; but when put on a hot stove, it will evaporate and become steam (gas). We breathe gases, drink liquids, and chew solids.

Yet, with this constant exposure, we seldom think about variations in matter as phases of matter. Figure 1 shows some characteristics of the three phases.

Solids. The solid phase of matter is common to our everyday life. We see and experience it constantly; sometimes by touch, sometimes by sight, and sometimes by taste. What are the characteristics of solids?

Figure 1 | Three Phases of Matter Common to Our Everyday Life

Describe a solid substance.

1.1 Use a pencil, ice cube, or block as an example of a solid and describe it in detail. Be sure to explain how the solid is different from a liquid or gas. _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

You probably included in your description of the solid such things as: a solid has definite shape, size, and mass; it is not free to move around and stays put when placed down on a surface; and it will turn into a liquid if warmed up enough. Solids are usually more dense than either gases or liquids. We know from our past studies that all matter is made of tiny particles called **atoms**. (The atoms can be grouped together to form a molecule.) The atoms or molecules in a solid are fastened together in regular spots. The particles are not free to move around very much because each is fastened tightly to its neighbor. An atom of solid can only vibrate around one position.

Liquids. We consume liquids every day when we drink water, milk or juice. Have you thought much about what liquids really are? In 1808 John Dalton published his theory of matter. He made these statements:

1. All matter consists of extremely small, indivisible particles called atoms.
2. All atoms of any one **element** are similar to one another, particularly in mass. But they are different from atoms of all other elements.
3. Chemical changes are changes in the combinations of atoms with one another.
4. Atoms remain indivisible in even the most violent chemical reaction.

In liquids, atoms are free to move around in the substance. The attraction forces between atoms "or molecules" are weak and may be dislodged by "stirring" or turbulent flow. During smooth flow the particles vibrate faster and slip past each other, often colliding with other particles. Liquids must be restrained to remain in one spot. They flow easily. Liquids take on the shape of the container. They have mass, and a fixed volume. Liquids have a flat-topped surface.

Complete these investigations.

These supplies are needed:

- 4 m of masking tape

Follow these directions and complete the written activities.

1.2 With masking tape, mark off a 100 cm by 100 cm square on the floor. Stand in the square, move around in the square, but always face the same direction—in a straight line.

a. Draw the motion in the box using lines to show the path of your motion.

b. Describe your motion. _____

_____

_____

1.3 Using the same square that you made in 1.2, move around as though you are a liquid with twists and turns in your motion.

a. Draw your movement in the box using lines to show your path.

b. Describe your motion. _____

_____

_____

1.2 a

1.3 a

Behavior of Solid and Gas Atoms Experiment

Describe the characteristics of a liquid.

1.4 Using water as an example, tell how liquids are different from solids. _____

_____

_____

_____

_____

_____

_____

Gases. Gases represent the least common state of matter on earth, but we experience gases directly every day. We breathe gases. We see the results of gaseous movement in the wind, in blowing up a balloon, or in drinking liquid through a straw. We could not live without the life-giving gas, oxygen. What else do we know about gases?

Let's investigate.

These supplies are needed:

- one balloon

1.5 Secure a balloon. Blow it up. Describe how gases cause the balloon to get bigger. _____

_____

_____

1.6 Let the balloon go so that the air escapes from the balloon. Describe why the balloon did what it did. _____

_____

_____

_____

_____

_____

_____

Behavior of Gas Atoms Experiment

Complete these activities.

1.7 Describe the characteristics of gases. Tell how gases are the same and how they are different from solids and liquids. _____

_____

_____

_____

_____

_____

_____

_____

1.8 Imagine that you are a gas particle. In addition to the back and forth motion and the turn around motion, you now are free to move from place to place without the restrictions of the box. Describe your motion as a gas particle and how it is different from your motion as a solid or liquid.

_____

_____

_____

1.9 Discuss the three phases of matter with your parents or other adults. Explain the characteristics of solids, liquids, and gases—how they move, how they are different, and how they are the same. When you have done so, get your parents' initials.

HELPER CHECK _____ initials _____ date

In summary you have seen that gases have no definite shape or volume, they take the shape and volume of the container, they can be compressed or dispersed, they will fill any shape or volume that is available, they have mass and low density, they have unrestricted movement, their particles vibrate very rapidly, are relatively far apart, and there are no forces holding them together.

ATOMIC STRUCTURE

We have seen from Dalton's ideas and from our previous studies that all matter is made up of tiny particles called atoms. Atoms are the basic building blocks of matter. Atoms come in one hundred six different varieties. Each variety is called an element. All of the atoms of one element are very much alike, but the atoms of different elements have different properties. Figure 2 shows these similarities and differences.

A. All atoms of an element are alike

B. Atoms of different elements are different

C. Atoms of different elements combine in a constant way to form compounds.

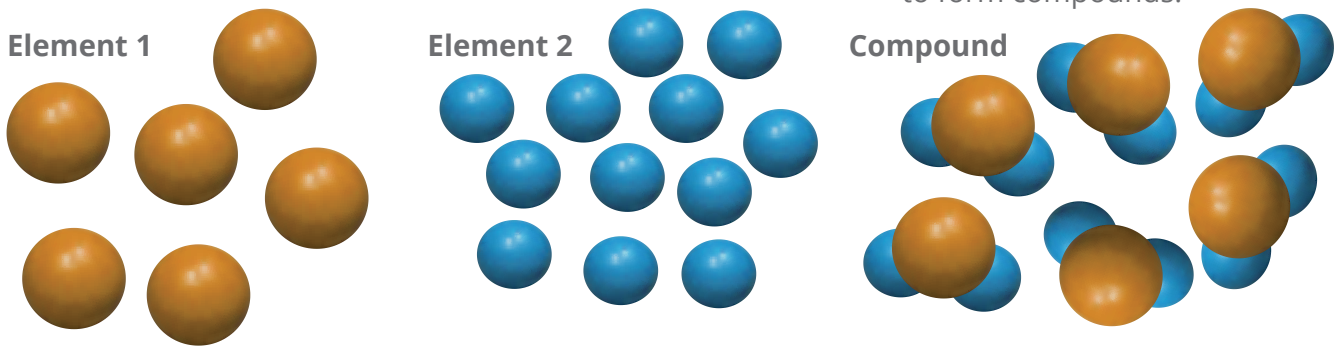

Figure 2 | Elements and Compounds

Particles of atoms. Since the time of Dalton, scientists have discovered that atoms are made up of three even smaller particles. These particles are the ones responsible for static electricity, the shock you get when you walk on a carpet and touch someone else, and the static cling of a clothes dryer or hair comb. Let's see if we can learn some things about these particles.

View 901 Magnets, from the Grade 9 SCIENCE EXPERIMENTS Video

Let's investigate.

These supplies are needed:

- 2 magnets marked with north and south poles
- 1 small piece of wood about the size of the magnets

Complete each activity and answer the questions.

1.10 Bring the two north poles together. Do they repel or attract? _____

1.11 Bring the two south poles together.

a. Do they attract or repel? _____

b. Does the N-N combination attract or repel? _____

c. Does the S-S combination attract or repel? _____

d. Do like poles attract or repel? _____

e. Does the N-S combination attract or repel? _____

f. Do unlike poles attract or repel? _____

1.12 Now bring the north pole near the wood. What happens? _____

1.13 Bring the south pole near the wood. What happens?

_____

1.14 Wood is not magnetic. Is a nonmagnetic substance affected by magnetic pull? _____

Magnet Experiment

Scientists have found that the three particles of matter behave toward one another just as the magnets and the wood. The three particles are called **electrons**, **protons**, and **neutrons**. The symbols are electrons (*e* or -), protons (*p* or +), and neutrons (*n* or o).

The electrons are like one pole of the magnet, and the protons are like the other. Neutrons are like the wood. Electrons have a negative electrical charge, the protons have a positive charge, and the neutrons have a neutral charge, or *no* charge. Let's now use this information to predict some results.

Complete these predictions.

1.15 Review your answers to 1.10-1.14 and apply those ideas here.

a. Will the e-e combination repel or attract? _____

b. Will the p-p combination repel or attract? _____

c. Will the e-p combination repel or attract? _____

d. Will the n-n combination repel or attract, or do neither? _____

e. Will the n-e combination or the n-p combination do anything? _____

f. Why or why not? _____

_____

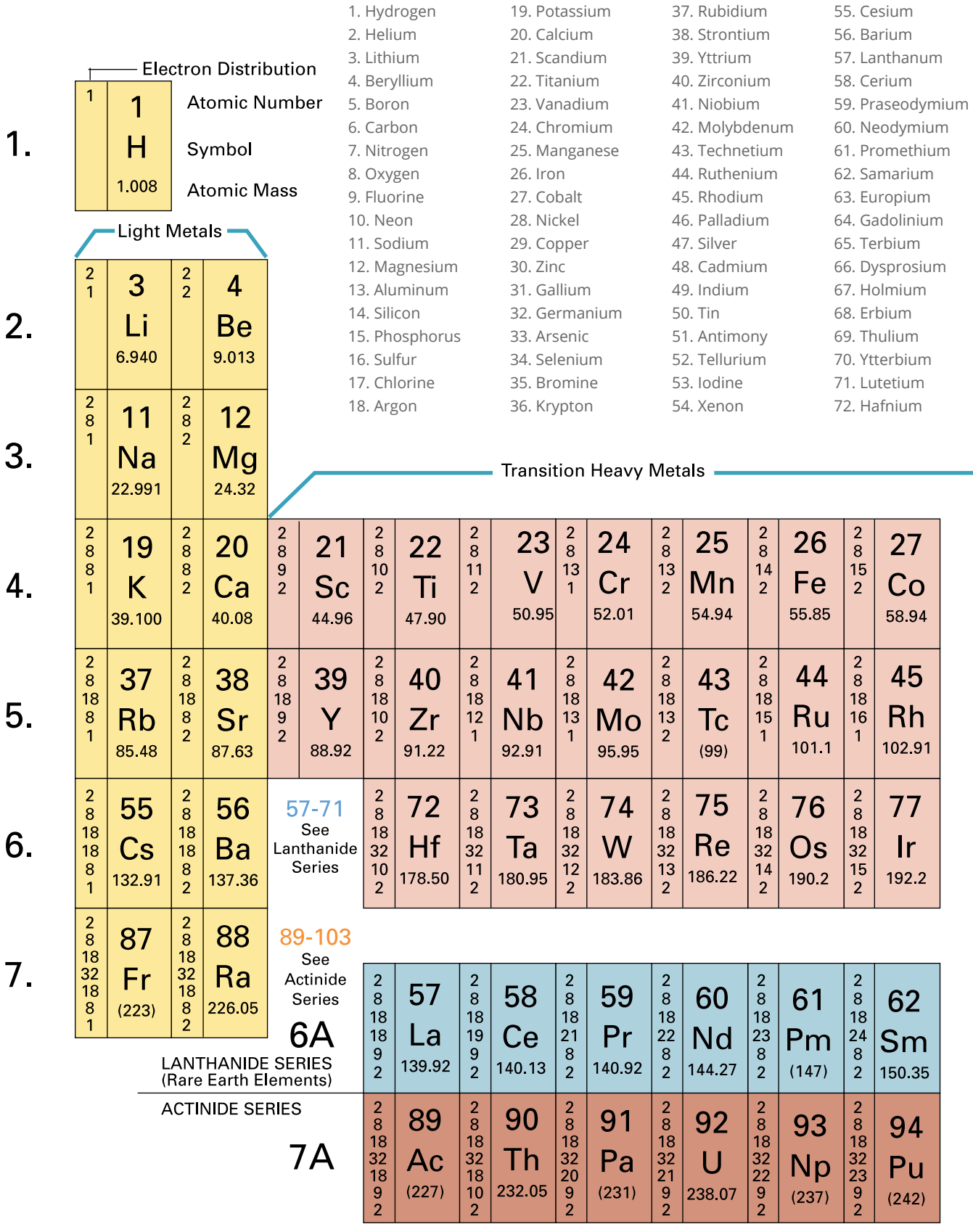

Figure 3 | Periodic Table of the Elements

73. Tantalum
74. Tungsten
75. Rhenium
76. Osmium
77. Iridium
78. Platinum
79. Gold
80. Mercury
81. Thallium
82. Lead
83. Bismuth
84. Polonium
85. Astatine
86. Radon
87. Francium
88. Radium
89. Actinium
90. Thorium

91. Protactinium
92. Uranium
93. Neptunium
94. Plutonium
95. Americium
96. Curium
97. Berkelium
98. Californium
99. Einsteinium
100. Fermium
101. Mendelevium
102. Nobelium
103. Lawrencium

THE PERIODIC TABLE OF THE ELEMENTS

Noble Gases

Nonmetals

															2	2	He 4.003
						2 3	5 B 10.82	2 4	6 C 12.011	2 5	7 N 14.008	2 6	8 O 16.000	2 7	9 F 19.00	2 8	10 Ne 20.183
						2 8 3	13 Al 26.98	2 8 4	14 Si 28.09	2 8 5	15 P 30.975	2 8 6	16 S 32.066	2 8 7	17 Cl 35.457	2 8 8	18 Ar 39.944
2 8 16 2	28 Ni 58.71	2 8 18 1	29 Cu 63.54	2 8 18 2	30 Zn 65.38	2 8 18 3	31 Ga 69.72	2 8 18 4	32 Ge 72.60	2 8 18 5	33 As 74.91	2 8 18 6	34 Se 78.96	2 8 18 7	35 Br 79.916	2 8 18 8	36 Kr 83.80
2 8 18 18	46 Pd 106.4	2 8 18 18 1	47 Ag 107.880	2 8 18 18 2	48 Cd 112.41	2 8 18 18 3	49 In 114.82	2 8 18 18 4	50 Sn 118.70	2 8 18 18 5	51 Sb 121.76	2 8 18 18 6	52 Te 127.61	2 8 18 18 7	53 I 126.91	2 8 18 18 8	54 Xe 131.30
2 8 18 32 17 1	78 Pt 195.09	2 8 18 32 18 1	79 Au 197.0	2 8 18 32 18 2	80 Hg 200.61	2 8 18 32 18 3	81 Tl 204.39	2 8 18 32 18 4	82 Pb 207.21	2 8 18 32 18 5	83 Bi 209.00	2 8 18 32 18 6	84 Po (210)	2 8 18 32 18 7	85 At (210)	2 8 18 32 18 8	86 Rn (222)

2 8 18 25 8 2	63 Eu 152.0	2 8 18 25 9 2	64 Gd 157.26	2 8 18 26 9 2	65 Tb 158.93	2 8 18 28 8 2	66 Dy 162.51	2 8 18 29 8 2	67 Ho 164.94	2 8 18 30 8 2	68 Er 167.27	2 8 18 31 8 2	69 Tm 168.94	2 8 18 32 8 2	70 Yb 173.04	2 8 18 32 9 2	71 Lu 174.99
2 8 18 32 24 9 2	95 Am (243)	2 8 18 32 25 9 2	96 Cm (247)	2 8 18 32 26 9 2	97 Bk (247)	2 8 18 32 27 9 2	98 Cf (251)	2 8 18 32 28 9 2	99 Es (252)	2 8 18 32 29 9 2	100 Fm (257)	2 8 18 32 30 9 2	101 Md (258)		102 No (259)		103 Lr (260)

Structure of atoms. We now know that all matter contains particles of electrons, protons, and neutrons. How are these particles arranged in an atom? Why don't the electrons attract the protons and get rid of each other? Do electrons, protons, and neutrons all have the same mass? Let's find out.

Many ideas have been proposed to explain the structure of an atom. Dalton's idea was that atoms were small, hard, indivisible spheres like BB's or lead shot. We now know this idea is not true. Atoms are mostly open space. One helpful model is shown in Figure 4. Here the **nucleus** is a small, dense part of the atom containing the protons and neutrons. The electrons revolve around the nucleus in paths far outside the nucleus. This spatial motion makes each atom very large but mostly open space. This model (Figure 4) is simple but will be helpful in this study. Since the protons and neutrons have about the same mass and each is about 2,000 times more massive than one electron, most of the mass is in the nucleus.

Each atom of an element has the same number of protons and electrons. They equal each other and therefore cancel out each other's charge. The number of protons in each atom

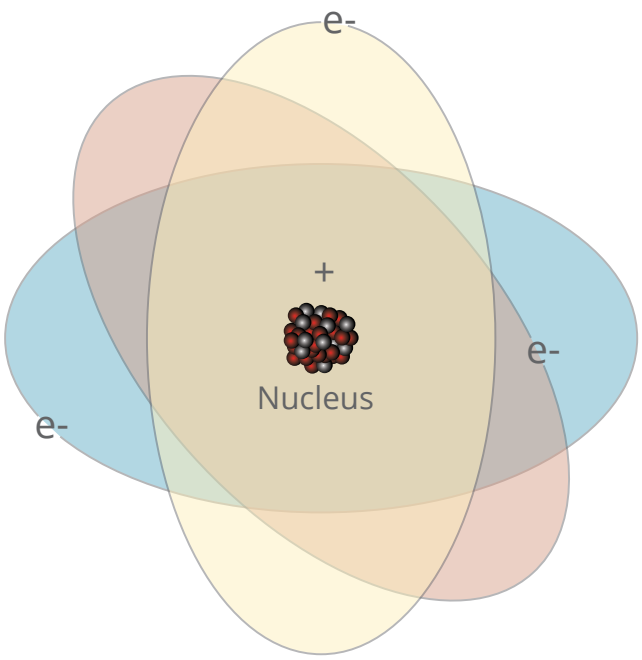

Figure 4 | Simple Structure of an Atom

of an element is the same, but the number of protons in each different element is different. The number of protons in an atom is called the **atomic number**.

The Periodic Table in Figure 3 lists the atomic number of the elements.

Complete these activities.

1.16 This chart contains the symbols for some common elements. Complete the chart from the data in the Periodic Table (Figure 3).

Element	Symbol	Atomic Number		Element	Symbol	Atomic Number	
hydrogen	H	a.		aluminum	Al	f.	
carbon	C	b.		sulfur	S	g.	
nitrogen	N	c.		calcium	Ca	h.	
oxygen	O	d.		iron	Fe	i.	
magnesium	Mg	e.		iodine	I	j.	

1.17 How many protons does each element have?

H = _____ Al = _____

C = _____ S = _____

N = _____ Ca = _____

O = _____ Fe = _____

Mg = _____ I = _____

1.18 How many electrons does each element have?

H = _____ Al = _____

C = _____ S = _____

N = _____ Ca = _____

O = _____ Fe = _____

Mg = _____ I = _____

View 901 Atomic Structure, from Grade 9 SCIENCE EXPERIMENTS Video

Complete this investigation.

These supplies are needed:

- 2 colors of clay (1/2 cup each)

Follow these directions.

- ☐ a. Let one color of clay represent protons and one color represent electrons.

  Proton color: _____

  Electron color: _____

- ☐ b. Make twenty-six small balls of each color clay to represent twenty-six electrons and twenty-six protons.

- ☐ c. For each element, place the correct number of proton balls in the middle.

- ☐ d. Next, place the correct number of electron balls, beginning with the innermost ring. Each pair in a ring must have one electron before any are paired up. When all pairs of a ring are filled, move to the next outer ring and continue until the proper number of electrons are placed for the element.

- ☐ e. Using the following drawing, place clay balls representing electrons and protons in the correct location and number in the atom.

Atomic Structure Experiment

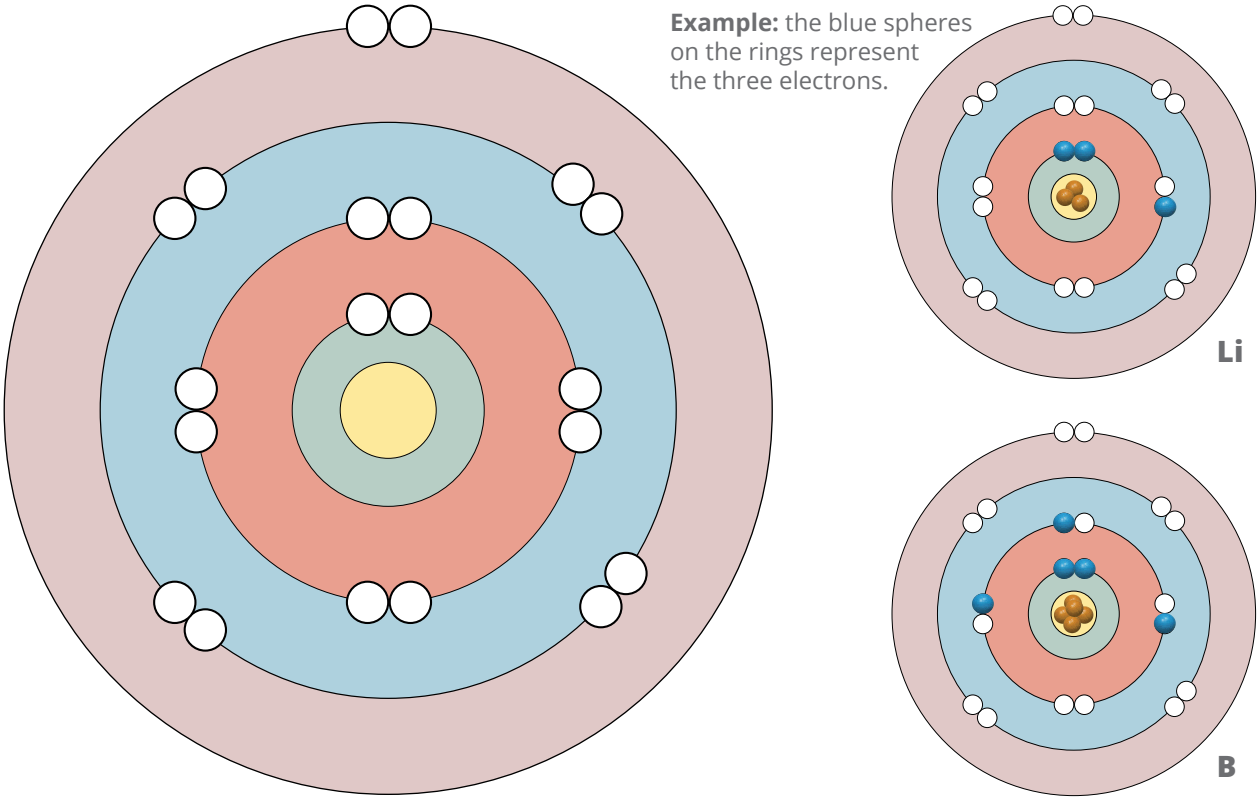

Figure 5 | Model of Atom Showing Electron Rings & Electron Position

Complete these drawings.

1.19 Using the model from the experiment, form each of the following elements. Using colored pencils to indicate electrons and protons, draw each element in the box.

a. H	b. He	c. C	d. O
e. Mg	f. Al	g. Ca	h. N

Complete these statements.

1.20 The protons and neutrons each have about _____ times the mass of one electron.

1.21 The a. _____ and b. _____ are located in the nucleus but the c. _____ circle outside the nucleus of an atom.

1.22 The _____ are in rings around the nucleus.

1.23 The a. _____ has a positive charge, the b. _____ has a negative charge, and the c. _____ has a neutral charge or no charge.

Complete this activity.

1.24 List the atomic number of each of the following elements.

Use Figure 3 for the information.

H = _____ Cu= _____

Si= _____ He= _____

Al= _____ Cl = _____

B = _____ Ag= _____

Pb= _____

Review the material in this section in preparation for the Self Test. The Self Test will check your mastery of this particular section. The items missed on this Self Test will indicate specific areas where restudy is needed for mastery.

SELF TEST 1

Match these items (each answer, 2 points).

1.01 _____ atomic number
1.02 _____ outside nucleus
1.03 _____ negative charge
1.04 _____ positive charge
1.05 _____ neutral
1.06 _____ p
1.07 _____ n
1.08 _____ e
1.09 _____ +
1.010 _____ o

a. proton
b. electron
c. neutron

Complete these statements (each answer, 3 points).

1.011 The three phases of matter are a. _____ , b. _____ , and c. _____ .

1.012 Solids are restricted to_____ motion.

1.013 Liquids have a. _____ and b. _____ of motion.

1.014 In addition to the two types of motion found in liquids, gases have _____ motion.

Draw the structure of the atoms listed in the boxes and label each part drawn. The number with each symbol is the atomic number for that element (each drawing, 3 points).

1.015

H = 1

1.016

C = 6

1.017

Na = 11

1.018

S = 16

Complete these lists (each answer, 3 points).

1.019 List three characteristics of solids.

a. _____

b. _____

c. _____

1.020 List three characteristics of liquids.

a. _____

b. _____

c. _____

1.021 List three characteristics of gases.

a. _____

b. _____

c. _____

64/80 **SCORE** _____ **TEACHER** _____ _____
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PUBLICATIONS

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

800-622-3070
www.aop.com