R.E.A.L. SCIENCE ODYSSEY

READ • **E**XPLORE • **A**BSORB • **L**EARN

Chemistry Level One
Unit Two: Starting Small

WRITTEN BY **BLAIR H. LEE, M.S.**

Pandia PRESS

Dear Customer,

Thank you for downloading Unit 2: Starting Small. This Unit is being offered to you at no charge for attending the SEA Homeschoolers Online Conference Series 2020. For more information about Pandia Press' full catalog of science and history courses, visit http://www.pandiapress.com.

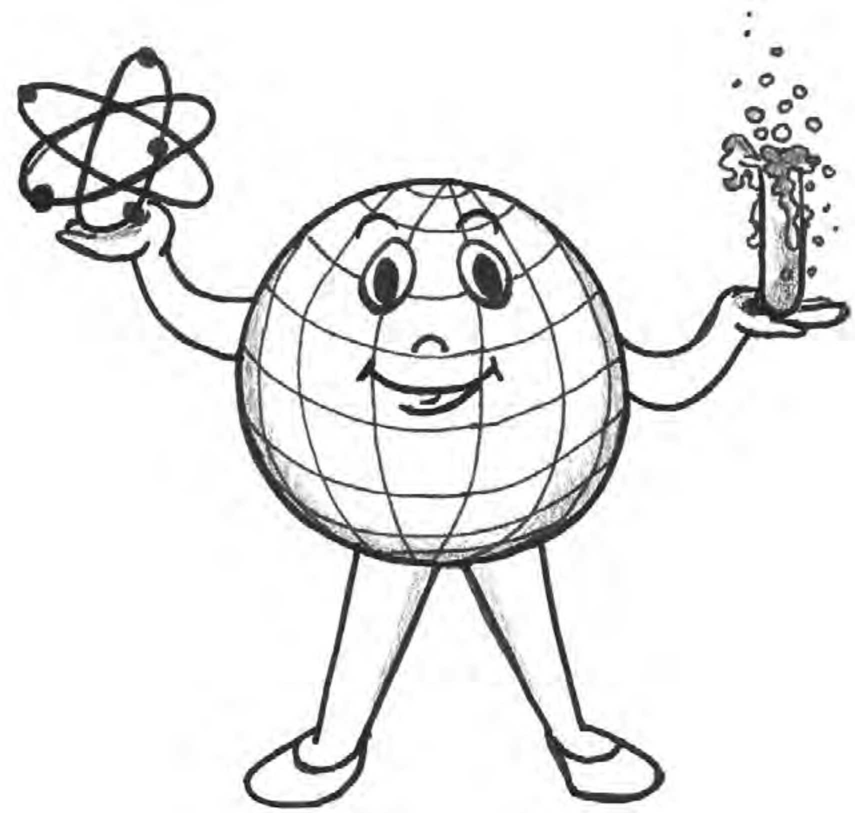
Thank you for your patronage and I hope you enjoy using your eBook.

Pandia Press, Inc.
Mount Dora, FL 32757
www.pandiapress.com
kate@pandiapress.com

Pandia PRESS

REAL Science Odyssey

Read · Explore · Absorb · Learn



Chemistry
Level 1

written by Blair H. Lee, M.S.

ISBN: 978-0-9798496-3-3

WHAT'S INSIDE THE COMPLETE CURRIULUM?

*Denotes lab or activity

An Introduction to RSO Chemistry

Atoms, molecules, chemical reactions, the periodic table—concepts intimidating enough to make a person weak in the knees! Young children can learn chemistry! Students as young as seven years old can successfully complete this course even though many of the concepts taught in this book are those usually reserved for high school. Don't worry, this book is written with the science novice in mind. Even if you have never been taught chemistry or don't know an electron from a proton, you will find yourself learning right alongside your child, and looking like a pro the whole time! You and your child will never look at a common piece of matter (like your shoe) the same again, without thinking about the billions and billions of molecules and atoms that make it up.

This course is not a collection of random labs, meant to entertain but with little real science. Nor is it a long progression of fill-in-the-blanks and trivial facts to be memorized and forgotten. Instead, this book is rich in vital concepts that will lay a firm foundation for studying chemistry in later years. This book is intended to be used from start to finish, like a math book. Concepts are taught through clever repetition and engaging labs, building upon one another and introducing science vocabulary and age-appropriate math gently and in context. There is particular emphasis placed on scientific method throughout this course. Students will learn how to speculate, hypothesize, experiment, observe, interpret, and conclude, just like real scientists.

A good chunk of this course is devoted to learning about the periodic table and studying several important elements on the table. Any serious study of chemistry must include the periodic table. It is the chemist's alphabet and it is as vital to chemistry as letters are to literature. When students are in a chemistry class later in life, they will have the background to advance further; they will not fear the table.

There is evidence that science is best learned when taught as a single subject and not lumped together with multiple mini-subjects taught in the span of a school year. That said, all the sciences do interrelate. Chemistry is the study of atoms, what they make, and how they interact. Since everything is made from atoms, the argument can be made that chemistry is the central science. Unfortunately, it is the science least likely to be taught before high school. The problem with that is, if you try to understand a scientific concept with any degree of depth, you had better know some chemistry. I have thought for some time now that educators start teaching chemistry too late. It is a fascinating subject, but there are new facts and new vocabulary, and you are learning about things that are the size of an atom—way too small to see! With chemistry, more than any other science, you often have to memorize a fact and take scientists' word for what is happening. The time to do that is not when someone is in high school or college; it is when a child is in the beginning stage of learning. This is the ideal time for absorbing facts, memorizing content, and filling a child's mind with the knowledge that creates a firm foundation for later years.

While creating this book, a lot of thought was given to teaching to the three main learning styles—visual, auditory, and tactile/kinesthetic. Science, by its very nature, lends itself to teaching to all three styles. With that in mind, each lesson in this book has visual, auditory, and tactile components. For visual learners, there are diagrams and charts that students help create and visualize. There are illustrations coupled with the text. There are crossword puzzles to help learn vocabulary words. The experiments have been carefully selected and designed to support the concepts taught in the text. Therefore, the experiments themselves are powerful visual aids.

For auditory learners, those who learn best through listening, there is the text itself, which has been designed to be read to students. There is a poem in each unit of this book to help reinforce vocabulary and key concepts. There are questions peppered throughout the text and within the experiments to help these students think through and hear the answers, thereby cementing the concepts being taught in an auditory fashion.

For tactile/kinesthetic learners, those who learn through moving, doing, and actively exploring the physical world, this book has been designed for them as well. There are activities that use movement to teach concepts. There are drawings and models to make. There are puzzles for students to put together. There are diagrams and charts to create. There are hands-on labs to perform, which directly teach to the concepts.

Science is a creative and thought-provoking endeavor. It is the one academic subject where you are supposed to move around and get your hands dirty. With such an emphasis on test scores these days, it seems breadth and depth in academics has been forgotten. It is time to bring science back as a core part of curriculum, engaging young people's minds with the stuff they really find interesting. Let's get started!

THE UNIQUE PAGES IN THIS BOOK

<u>For My Notebook Pages</u>

1. All the student pages have a boxed outline around the material presented. That way it is easy to identify what is for the child and what is for the parent or teacher.
2. The For My Notebook (FMN) pages are the lesson pages that present the majority of new material to the student. They are intended to be read aloud. Some students, who are good readers, may want to read the FMN pages aloud themselves to the parent or class. However orchestrated, these pages are intended to be read aloud and not silently, to encourage discussion and questions.
3. New vocabulary words are underlined. You will notice that many of the vocabulary words are not presented with a classic dictionary definition. Instead, the explanation is given in context so it is "felt" rather than memorized. Formal definitions for the vocabulary words are offered in the back of the book.

<u>Lab Sheets</u>

1. The lab sheets are those pages that the student writes on. They also have a boxed outline because they are intended for the student, not the parent/teacher, to complete.
2. The lab sheets not only reinforce the material presented in the FMN pages, but they are also the vehicle through which this course reinforces and formalizes scientific method. On the lab sheets, students will be making hypotheses based on questions formed during the lesson. Students record observations and lab results, and make conclusions based on those results. They will also practice sketching details of their lab experiences, an important process that reinforces observation skills.
3. If you are working with a student who isn't writing yet, then have him dictate the information to be written on the lab sheets. If your student is unable to draw (meaning physically incapable; I'm not referring to artistic abilities), then have him describe in detail his observations as you create them on the lab sheet.

<u>The Instructor Pages</u>

1. The instructor pages contain the supply lists for the labs or activities and procedure instructions.
2. These pages are written for the parent/teacher, but the procedure is often written as if for the student. For example, "Complete the hypothesis portion of the lab sheet," is instruction for the student, not the parent.
3. Most instruction pages include a prompt to read aloud to students. A great deal of course instruction is found in these prompts. If you dislike prompts, then be sure to present the information in your own words.

<u>Poem Pages and Crossword Puzzles</u>

1. Each unit contains a poem and a crossword puzzle that are intended to help reinforce vocabulary and key concepts.
2. The poems can be used as you wish—recite, memorize, transcribe, illustrate. Concepts learned to verse are learned more quickly and not as easily forgotten.
3. The crossword puzzles review the vocabulary presented in each unit.

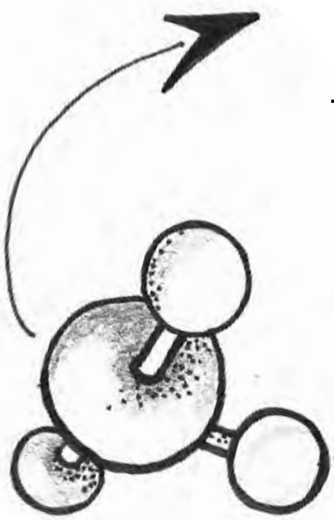
Unit 2

Starting Small

The Atom Song

An atom
is so small
you can't see it,
not at all!

But without atoms
none of us
would be.
They make up
everything
you see.



Pandia PRESS

NAME ______________________________ DATE ________________

For my notebook

The Atom

Have you heard of <u>atoms</u>? Did you know that everything in the world and the universe is made of atoms? Atoms are the basic building blocks of everything you see, including yourself. That means even <u>cells</u> are made of atoms. You remember what cells are, don't you? They are the building blocks of living things, and atoms are the building blocks of them. Atoms are like the Legos of the universe, only atoms are a lot smaller than Legos. They are so small that a person who weighs 75 pounds would have about 3,500,000, 000,000,000,000,000,000,000 (three octillion, five hundred septillion) atoms in his body! Try writing that number down; it's 35 followed by twenty-six zeros.

Thousands of years ago, the ancient Greeks thought a lot about how things are made. About 2,400 years ago, a Greek named <u>Democritus</u> (dih-MOCK-rih-tuss) said that everything was made from particles, called atoms. He thought that all things could be broken down into smaller and smaller pieces until you got to atoms. Democritus also thought atoms moved all the time and that they could join with each other.

The problem with Democritus's <u>theory</u> about atoms was that at that time, there was no scientific way to prove that atoms exist. Atoms are so small that people cannot see them without using a special type of microscope called a <u>scanning-tunneling microscope</u>. There were no scanning-tunneling microscopes 2,400 years ago. Most people living then found it hard to believe in something they could not see. That meant most of the people alive when Democritus was alive did not believe in atoms.

Today we know that Democritus was right. All things are made of atoms. He was right that atoms move all the time. He was also correct that atoms join together. When atoms join, they make <u>molecules</u>.

Move your hands in the air. As you move your hands through the air, you are hitting atoms and molecules. You cannot see them, but they are there. Air is mostly made of two types of atoms whose names are <u>nitrogen</u> and <u>oxygen</u>. Water is made of atoms, too. Water is made of two types of atoms called <u>hydrogen</u> and oxygen. Everything is made of atoms!

The Atom Lab #1: Are Atoms Small? - instructions

Materials:

- Lab sheet, pencil
- Five balloons that have not been inflated
- Almond extract
- Water
- Cinnamon
- Lemon, orange, or peppermint extract
- Magnifying glass
- ½ teaspoon measuring spoon
- Permanent marker

Part 1:

Aloud: Atoms are really small. Think of the smallest thing you have ever seen with your own two eyes. Atoms are a lot smaller than even that. Look at your lab sheet. Do you see the dash under the magnifying glass? How many atoms do you think are in that dash?

Procedure:

Have students trace over the dash on the lab sheet with a pencil, and examine it with a magnifying glass. Wait for students to write a guess about the number of atoms.

Aloud: There are 40,000,000 (40 million) atoms in that dash! Atoms are small, but everything is made of them. The next time you go outside, look at all the different things in the world that are made of atoms. If it is a sunny day, remember even the sun is made of atoms. If it is rainy or cloudy, remember that the clouds and the raindrops are all made of atoms. Oh, by the way, a raindrop has about 5,000,000,000,000,000,000,000 (5 sextillion) atoms in it. If you catch one on your tongue, think about that! Do you remember what kind of atoms are in raindrops? There are hydrogen atoms and oxygen atoms in raindrops because raindrops are made of water.

Instructor's Notes:

The dash is 2mm long. There are about 20 million carbon (graphite) atoms in a pencil dash that is 1 mm.

Part 2:

Aloud: What does the outside of a balloon smell like? Would you say sort of rubbery or like nothing at all? What if you put something with a strong scent or smell into a balloon? Would you be able to smell what's in the balloon if you inflated it? How could you? Maybe you could put a small hole in it. The problem with that is, if a balloon had a hole, it wouldn't hold air, would it?

Today, you are going to smell five balloons. Each balloon has something different in it. You will see if you can smell the scent atoms through the balloons.

Balloons are made of atoms like everything else in the world. The things you will be putting into the balloons are made of atoms, too. Do you think the scent atoms will be small enough to go through the atoms of the balloon?

Procedure (read over the entire procedure before starting the lab):

1. Complete the hypothesis portion of the lab sheet.
2. Before inflating the balloons, have students examine them. They should smell them and check them for holes with a magnifying glass. If they find a hole in a balloon, discard it and get another with no holes. Blow up one of the balloons and have the students examine this balloon with the magnifying glass. They are checking it for holes.

(continued on the back)

3. Do this next step before inflating the rest of the balloons and out of sight of your students. Pour water, cinnamon, almond extract, and the other type of extract in four different balloons. After each addition, blow up the balloon and tie off tightly. Do not over-inflate the balloons. If you do, they could pop and you will have a mess. Be careful not to get anything on the outside of the balloons or your hands. If you do get something on the balloon, wash it off with soap and let it dry. Label the balloons 1, 2, 3, and 4, or you can use different-colored balloons for identification. The students will guess what is in them. The rest of the experiment is done in front of the students. Shake each balloon for 30 seconds starting with the balloon that has only air in it. Have students smell the outside of the balloon. Have them record results on the lab sheet.

Instructor's Notes:

- If you use peppermint extract, put it at the end of the experiment. It smells so strong that it can affect how the unscented balloons smell. You might want to leave it in another room until all the other balloons have been tested.
- Cinnamon and vanilla extract can be seen through light-colored balloons. Try using a dark-colored balloon for these scents.

Possible Answers:

Results / Observations:

Before being inflated, the balloons should smell like nothing, or rubbery, or like a balloon.
Before and after the balloons are inflated, students should not see any holes in the balloons.

Data Table:

Students should fill in the part of the data table where they guess what the balloons have in them. You should help them fill in the part that tells what was really in the balloons.

They should smell both extracts and cinnamon. They should not smell anything from the balloon with air in it and the balloon with water in it. They might correctly guess the balloon with water because they will be able to hear that it has liquid in it.

Discussion/Conclusion:

They should have smelled all three things that had a scent. From this, students should have learned that the scent molecules and atoms are small enough to travel between the atoms that make up the balloon.

NAME ______________________________ **DATE** ________________

The Atom Lab #1: Are Atoms Small?

Part 1:

–

I think there are ____________________________________ atoms in that dash.

Part 2:
Hypotheses (circle your answers):
I think scent molecules are small enough to travel through the molecules of the balloons and that I will smell the scents put in the balloons.

Yes No I don't know

I think the balloons with air and water will smell the same as they did before being inflated.

Yes No I don't know

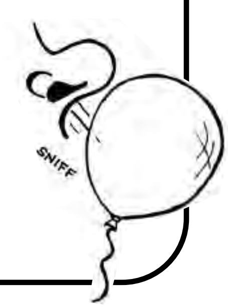
Results / Observations:
Before being blown up, my balloons smelled like ____________________
When I looked at the balloon with my magnifying glass, I saw:
Before being blown up ____
After being blown up ____

Data Table	The balloon smelled like	What was in the balloon?
balloon filled with air		*air*
balloon #1		
balloon #2		
balloon #3		
balloon #4		

Discussion and Conclusion:
Did you smell any of the things put into the balloons?

Which ones did you smell?

What did the scents teach you about the size of atoms and molecules?



The Atom Lab #2: Do Atoms Move? - instructions

CAUTION: This lab involves handling very hot water.

Materials:

- Lab sheet, pencil
- Color pencil or crayon (same color as the food coloring)
- 3 cups of Water at three different temperatures:
  1) Chilled (Put ice and water into a container and drain off the water for use.)
  2) Room temperature
  3) Very hot (just been boiled)
- Food coloring (Use the same color and amount for each test. A darker color is better.)
- Three clear glasses, the same size
- Thermometer, science or kitchen-type
- Stopwatch or a timer that counts in seconds

Aloud: When you look at a drop of water, can you tell that the hydrogen and oxygen atoms in it are moving? Well, they are moving, and very fast, too. In this lab, you are going to drop food coloring into water. You will not see a single food color atom move through the water; atoms are too small to see by themselves. But you can see a group of food color atoms move through the water. When you put the drops in the water, the food coloring will mix with the water without you stirring it. When things mix without being stirred, it is called <u>diffusion</u>. Temperature can affect how fast atoms and molecules mix with each other. The water in each glass will be a different temperature. Do you think the molecules will diffuse faster in the hot water or the cold water?

Procedure:

1. Complete the hypothesis portion of the lab sheet.
2. Measure one cup of each temperature of water into three clear glasses.
3. Right away, measure the temperature of each glass of water. Do this very carefully so you don't stir the water. (To prevent the thermometer from shattering, allow it to cool for a few seconds between the hot and cold water.) When the thermometer stops moving up or down, record the temperatures on the lab sheet.
4. Carefully drop 5 drops of food coloring into each glass of water.
5. Immediately observe what happens in each glass and record observations on the lab sheet. Observations should be recorded in words and pictures.
6. Wait 2 minutes. Measure the three temperatures again. Record observations on the lab sheet.
7. Wait 30 minutes. Measure the three temperatures again. Have there been any changes?
8. Complete the lab report.

Aloud: When you can see things diffuse, you are watching molecules and atoms in motion. Heat can make atoms and molecules move faster. You used colored molecules in this experiment so it would be easy to see them move through the colorless water. But atoms are moving all the time, even when you can't see them.

Instructor's Notes:

- Make sure each glass has the same amount of water. If you use more or less than a cup of water, the rate of diffusion will be affected.
- Make sure the water is not stirred, or otherwise moving, when you carefully drop in the food coloring. You want the atoms to mix through diffusion, not from stirring.
- When food coloring is put in the hot water, it diffuses very quickly. Make sure students are watching the experiment right from the start.
- Thirty minutes might not be enough time for the food color to diffuse completely through the water in the room temperature and cold water. Try leaving the glasses sitting out until the color diffuses completely.

(continued on the back)

Possible Answers:

Hypotheses:
The correct answers are yes, yes, hot.

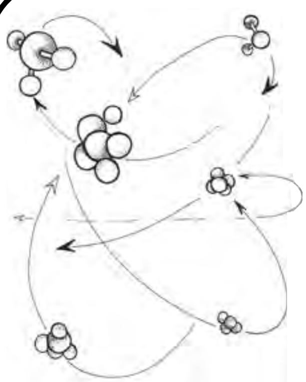
Results:
Data Table
The temperatures will vary.

Observations:
Each square represents a glass of water with food coloring in it. The coloring in each square should look similar to the diffusion pattern in each glass of water + food coloring at the specified time.

Conclusion:
The atoms diffused fastest in hot water.
The atoms diffused slowest in cold water.

NAME ______________________________ DATE ____________________

The Atom Lab #2: Do Atoms Move?



Hypotheses:

Do you think you will see the food color atoms diffuse (move) through the water?

Yes No I don't know

Do you think the temperature of the water affects the rate of diffusion (how fast things move) in the water?

Yes No I don't know

I think atoms move faster when they are ________________.

cold room temperature hot

Results:

Temperature:	Chilled water	Room temperature water	Hot water
Start			
2 minutes			
30 minutes			

Observations: Color the squares to show what is happening to the food coloring in each glass of water.

Chilled water			Room temperature water			Hot water		
Start	2 min	30 min	Start	2 min	30 min	Start	2 min	30 min

Conclusion: Circle the correct word(s) to complete each sentence.

The atoms diffused fastest in cold room temperature hot water.

The atoms diffused slowest in cold room temperature hot water.

What's in an Atom?

So what's in an atom?
Let's start
And learn
Each part.

Proton,
Electron,
Neutron,
Yeah.

Inside the nucleus,
There are two kinds of things,
The neutral neutron
And the positive proton.
They're good friends,
Like you and me.
They don't like to be seen separately.

Proton,
Electron,
Neutron,
Yeah!

Then there's a little guy
Orbiting around.
He's really fast
But he doesn't make a sound.
He's the electron
And he's negatively charged.
He's really small.
He's not at all large.

Proton,
Electron,
Neutron,
Yeah!!

Proton,
Electron,
Neutron,
Yeah!!!

Proton,
Electron,
Neutron,
Yeah!!!!

Parts! Poster -instructions

Materials:

- "Parts of an Atom" poster (p. 47), 1 per student
- Crayons or colored pencils - purple, red, blue, green, and orange
- Construction Paper - one 8 ½ " x 11" piece
- Glue
- "What's in an Atom?" poem (p. 44)

Hand out the "Parts of the Atom" poster found on page 47. Students should follow along on it while you read below.

Aloud: The picture on the poster shows the parts of an atom. Atoms are very small, but there is something even smaller than atoms. Atoms are made of three main parts, and the parts that make up atoms are smaller than atoms. These three parts are called <u>protons</u> (proh-tonz), <u>neutrons</u> (noo-tronz), and <u>electrons</u> (ee-lek-tronz).

Let's learn what an atom looks like. I am going to read a description of the parts of an atom to you. I want you to follow along on your Parts of an Atom poster using your crayons.

Look in the center of the atom. Do you see the four circles in the center of the atom? This center part of an atom has a special name. It is called the <u>nucleus</u> (noo-klee-uhss). With a purple crayon, draw one tight circle around all four circles in the nucleus. Can you find the word "nucleus" in the word box? Shade the word "nucleus" purple. The nucleus is made of things called protons and neutrons.

Find the two neutrons by looking for the letter "n" inside two of the circles in the nucleus. Color the neutrons blue. Look at the neutrons. They look the same as each other. That is because all neutrons are the same as each other. Find the word "neutron" in the word box. Shade the word "neutron" blue.

The two protons in the nucleus have a "p+" inside their circles. Color the protons red. Look at the protons. They look the same as each other. That is because all protons are the same as each other. Find the word "proton" in the word box. Shade the word "proton" red.

An electron is a small particle that orbits around the nucleus. There are two of them; they have an "e-" in their circles. Can you find both of them? Color them green. Look at the electrons. They look the same as each other. That is because all electrons are the same as each other. Shade the word "electron" green.

The <u>energy level</u> is where you find the electrons of an atom. Trace over the energy level, the big circle the electrons are in, with an orange crayon. Shade the words "energy level" at the top of the page orange.

Now there is one last part of your atom I want you to notice. Well, it's actually not a part, but rather the lack of a part. Let me explain. Do you notice what is between the nucleus where the protons and neutrons are and the energy level where the electrons are? Nothing! Atoms have a whole lot of empty space in them. In fact, empty space is the biggest "part" of an atom.

Cut out your Parts of an Atom poster and glue it onto a piece of construction paper. Hang it on your wall to help you remember the parts of the atom while you study chemistry this year.

The atom you just colored is a <u>helium</u> (HEE-lee-em) atom. It is a special type of atom. Helium is used in balloons to make them float. It is also what they put in blimps to make them lighter than air.

Instructor's Notes:

- The Parts of the Atom poster created today is used as a reference by students throughout this book.
- Recite the "What's in an Atom?" poem to help students remember the parts of an atom.
- Throughout this course I will be referring to electrons being on energy levels as they circle the nucleus in an atom. Traditionally these circles were called "orbits," but recent atomic discoveries have led to the more accurate term "energy level." Whether energy level or orbit, when teaching about atoms we draw models with electrons neatly circling the nucleus. But the fact is, the placement of electrons is more accurately described as a cloud, and the location of electrons in a cloud is determined by a probability function. For this age-group, however, this concept is best taught as tidy energy levels.

(continued on the back)

For More Lab Fun:

If you have a group of three or more students, try acting out an atom while reciting the "What's in an Atom?" poem. Have students play the parts of the "proton" and the "neutron" standing very close together in the center, and the "electron" orbiting around them in the "energy level." Clap and shout the chorus.

Recite "What's in an Atom?" at the start of each science class for the next few weeks until students know the parts of an atom well. Then review the poem periodically throughout the school year.

NAME ______________________________ DATE ____________________

Parts of an Atom

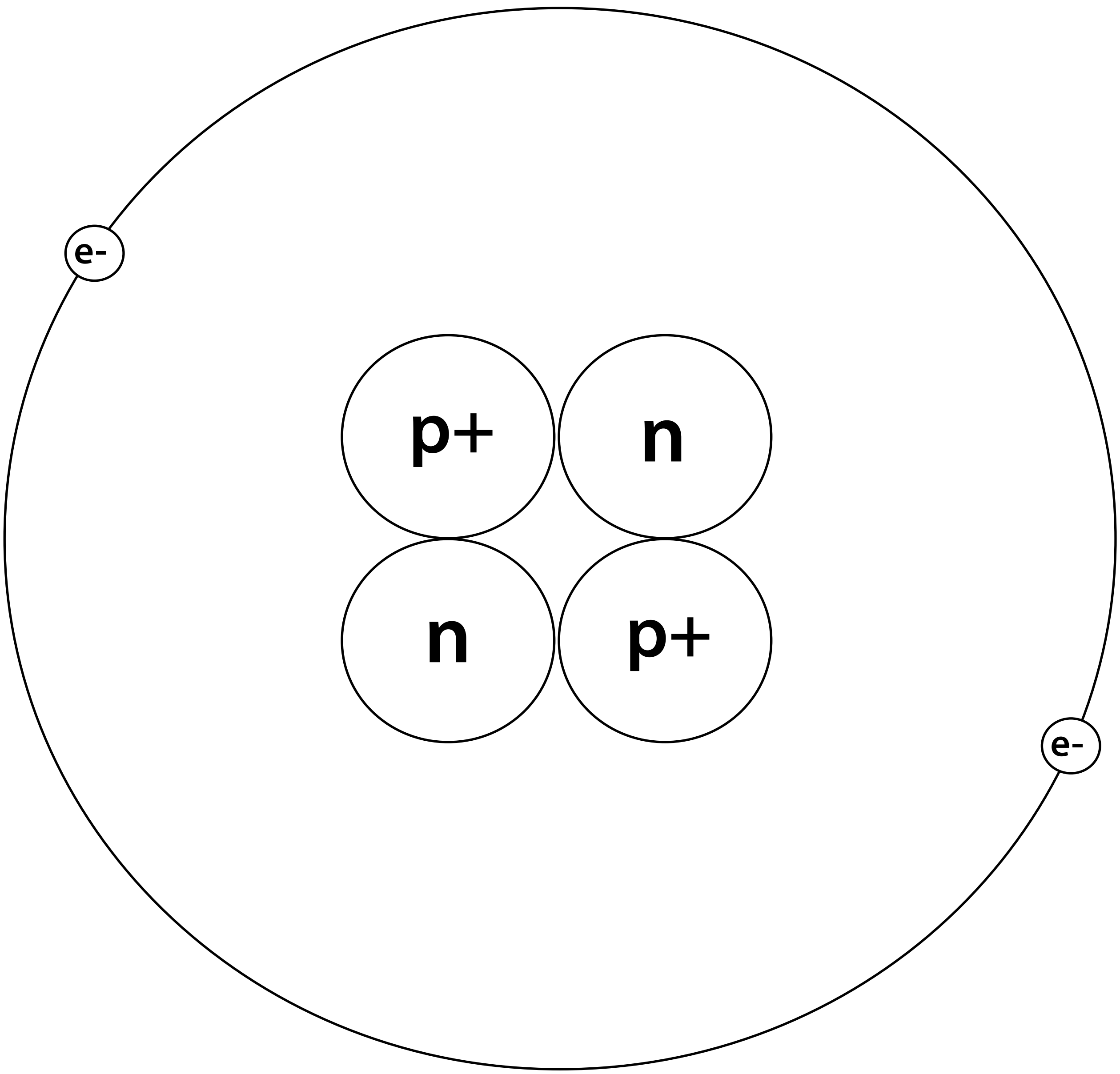
nucleus

proton (p+)

neutron (n)

electron (e-)

energy level



Helium (He)

Parts! Lab: Let's Be Positive - instructions

Materials:
- Copy of lab sheet, pencil
- Inflated balloon
- Wall
- Mirror
- Carpet or sofa covered in cloth material (leather sofas won't work)
- Completed "Parts of an Atom" poster

Aloud: Have you ever gotten a shock when you touched something or someone? Have you taken something out of the dryer and had it cling to you? These things happen when enough <u>electric charge</u> builds up and moves from one thing to another.

Are you thinking, "Hey, wait a minute! Isn't charge what horses do at the start of a battle?" Maybe you are thinking, "Isn't charging what my mom does when she goes shopping?" You can see both of those types of charge. You can see the other type of charge, too.

The electrons orbit around the outside of the atom and sometimes you can rub them off onto something else. A charge can be either positive or negative. Do you notice the protons have "+" signs and the electrons have "-" signs in the atom on the "Parts of an Atom" poster? Protons have positive charge and electrons have negative charge. That is why there are "+" signs in the protons and "-" signs in the electrons.

When you rub a balloon on carpet or a sofa, electrons will rub off them and on the balloon. The balloon will have a negative charge from the electrons because of this. The positive part of your hair and the wall will be attracted to the negatively charged balloon. Opposites really do attract!

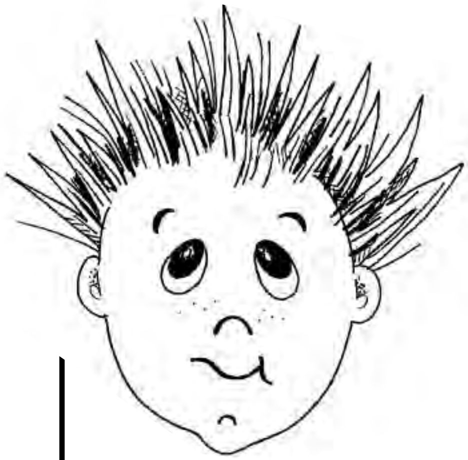
Procedure:
1. Before rubbing the balloon on anything, put the balloon next to a student's hair and the wall. Have students record their observations on the lab sheet.
2. Rub the balloon ONLY in one direction on your carpet or sofa. Rub it five to ten times. Be careful not to pop the balloon.
3. After rubbing the balloon, hold it next to a student's hair and let him look in a mirror. After that, touch the balloon to a wall. Have students record their observations on the lab sheet.

Aloud: When the balloon is rubbed on the sofa/carpet, electrons rub off the sofa/carpet and onto the balloon. The extra electrons on the balloon attract the protons in your hair and on the wall. Try it on more things. If you rub the balloon again, though, make sure you do not rub it in a different direction.

Instructor's Note:
- If it is humid or rainy where you live, this might not work. Wait for a drier day.

Possible Answers:
Before rubbing the balloon: nothing happened, nothing happened
The pictures should show hair standing up and a balloon sticking to the wall.

NAME ________________________________ DATE ________________



Parts! Lab: Let's Be Positive

Before rubbing the balloon on the carpet or sofa, . . .

when I held the balloon close to my hair

____

____

____.

when I held the balloon close to the wall ___________

____

____.

Results: Draw pictures to show what happened after rubbing the balloon.

When I held the balloon close to my hair, it looked like this:

When I held the balloon close to the wall, it looked like this:

NAME ________________________________ DATE __________________

For my notebook

Types!

The atom on your "Parts of an Atom" poster is a special type of atom. It is a helium atom. There are over 100 different types of atoms. Isn't that a lot? How could that be if all atoms are made of the same three things—electrons, protons, and neutrons? It is true, though. Just look around you. Isn't it incredible that all the things you can see are made from the same three things?

So, if everything is made up of the same three things—protons, electrons, and neutrons, then what makes one type of atom different from another? Think of a piece of aluminum foil and a pencil lead. Aluminum foil is made of <u>aluminum</u> atoms, and a pencil lead is made of <u>carbon</u> atoms. Remember, an electron in an aluminum atom is exactly the same as an electron in a carbon atom. The protons are all the same as each other in both atoms and so are the neutrons. Aluminum and carbon look so different from each other, it is hard to believe they are made from the same things, isn't it? An atom of aluminum has more protons, neutrons, and electrons than an atom of carbon, and that is all that makes it different. Wow!

Aluminum foil is made of LOTS of aluminum atoms. The tip of the pencil is made of LOTS of carbon atoms. A group of the same type of atoms is called an <u>element</u>. When you look at aluminum foil, you are looking at the element aluminum because there is only one type of atom in the foil (aluminum atoms) and there is more than one of them. The pencil lead is the element carbon because it is made up of only carbon atoms.

Types! Lab: The First Ten - instructions

Materials:

- Lab sheet, pencil
- Small piece of aluminum foil
- Pencil lead or a sharpened pencil
- One bag of mini marshmallows—all the same color (e.g. white)
- Two bags of regular-size marshmallows, 2 different colors—besides traditional white, you should be able to find chocolate (brown) and/or strawberry (pink) marshmallows
- Ten blank sheets of paper (8 ½ x 11)
- Large table, counter, or floor space where you can spread out 10 marshmallow atoms (at least 10 feet wide)
- Kitchen scale
- "Parts of an Atom" poster (completed) and "What's in an Atom?" poem
- Scissors
- Atomic Energy Levels Diagram (page 59)
- Periodic table found on the inside back cover of this book

Aloud: Look at the piece of aluminum foil* and the pencil lead*. Remember that the only difference between them is that aluminum atoms have more electrons, protons, and neutrons than the carbon atoms making up the pencil lead. Today you will make ten different types of atoms using marshmallows, and the only difference between them will be the number of protons, electrons, and neutrons. Each different type of atom in the universe has its own name. There are more than 100 and the number keeps growing. That means there are over 100 names for the types of atoms. Today you will make the first 10 types of atoms.

* There are impurities (small amounts of other types of atoms) found in aluminum foil and pencil leads. For the sake of teaching elements, I ignored this fact.

Procedure:

1. Let students examine and compare the aluminum foil and pencil lead.
2. Cut out the name squares of the different types of atoms on the lab sheet. The pronunciation for them is given as each type of atom is introduced. There is a number by each name. The numbers are the atomic numbers and also indicate the order in which you will make the atoms. The name with the number 1 by it, for example, is the atom that is made first.
3. Before beginning to build the atoms, use the "Parts of an Atom" poster that students made last week and "What's in an Atom?" poem to refresh their memories about what an atom looks like.
4. Decide which color of the regular-size marshmallows will be protons and which will be neutrons. The mini marshmallows will be electrons.
5. Students should build each atom on a separate sheet of blank paper as you read the scripted directions found on the next page. Work your way through building the atoms one at a time, beginning with hydrogen and ending with neon, placing the marshmallow protons, neutrons, and electrons in their proper places for each atom. As students make the atoms, have them put the matching atom name label on the sheet and write in the missing number of protons, electrons, and neutrons on the label.

Instructor Notes:

- This lab is in two parts: building the marshmallow atoms and then placing the marshmallow electrons in energy levels. You might choose to do both parts consecutively, in one long lab. If you choose to split this into two days, you have to rebuild the marshmallow atoms for the second day.
- Look at the periodic table found on the inside back cover of this book to assist you with placement of the marshmallow atoms on your work surface. The placement is important because it mimics the periodic table, which students will learn about later in this course.

(continued on the back)

- The number of neutrons does not increase by a consistent amount. Therefore, you will provide the number of neutrons for the student every time. The number of protons and electrons increases by one, going from one type of atom to the next. You will begin writing the numbers of protons and neutrons for students until a point, noted in the text. After that, you will discuss the pattern and students will help determine the correct number of protons and neutrons to write down.
- Many of the names of the atom types (element names) will not be familiar to your students. It is not the purpose of this lab to teach what these elements are. That is done in another unit. The names are given here as a way to distinguish the different types of atoms.
- As students build atoms, the number of protons and neutrons will increase. In order to fit all the marshmallows on the paper, you may have to stack the "protons" and "neutrons" on top of each other.

Aloud Part 1 - Building Atoms:

neutron 0
proton 1
electron 1

1. Let's start making atoms. First is hydrogen (HI-dreh-jen).

- **Put a blank piece of paper on the top left side of your work surface. Cut out all of the atom labels found on the lab sheet. Glue or tape the name "hydrogen" onto the top of the paper.**
- **You need one proton for your hydrogen atom. Where should you put it? (nucleus)**
- **Now take one electron and put this orbiting the nucleus.**
- **You have now made a hydrogen atom. Wait! Did I forget something? Where is the neutron? Guess what? Hydrogen does not have one, it just has a proton and an electron. Neutrons are funny little guys; sometimes they match the number of protons and sometimes they don't. I will tell you how many neutrons you need for each type of atom.**

neutron 2
proton 2
electron 2

2. Helium is #2. (HEE-lee-em)

- **Put another blank piece of paper on the far right side of your work surface. Glue or tape the name "helium" onto the top of the paper.**
- **You need two protons and two neutrons for helium. Did you put these in the center of the atom? They make up the nucleus.**
- **Next, you need two electrons orbiting the nucleus.**

neutron 4
proton 3
electron 3

3. Lithium is #3. (LITH-ee-em)

- **Start a second row of atoms by placing a blank piece of paper with the label for lithium below the hydrogen atom.**
- **Lithium has three protons and four neutrons in its nucleus.**
- **All the atoms you are making today have the same number of electrons as protons. How many electrons does lithium have? (3) Write the number of electrons on the label.**

Now I want to teach you something important. Answer these questions for me.
How many protons does hydrogen have? (1) How many electrons does hydrogen have? (1)
How many protons does helium have? (2) How many electrons does helium have? (2)
How many protons does lithium have? (3) How many electrons does lithium have? (3)
Do you see a pattern?
When going from one type of atom to the one that is next in line, you ALWAYS add 1 and ONLY 1 proton and 1 electron. Let's make more atoms and see how this works.

neutron 5
proton 4
electron 4

4. Beryllium is #4. (beh-RIL-ee-em)

- **Place the paper for beryllium to the right of lithium.**
- **If hydrogen has 1 proton, helium has 2 protons, and lithium has 3 protons, how many protons does beryllium have? (4)**
- **Make the nucleus for beryllium. It has five neutrons.**
- **Beryllium has four electrons.**
- **Write the number of protons and electrons on the label.**

neutron 6
proton 5
electron 5

5. Boron is #5. (BO-ron)
- Put a sheet of paper and the label for boron next to beryllium.
  - Boron has six neutrons.
  - How many protons and electrons does it have? (5)
- Construct a marshmallow boron atom and write the number of protons and electrons on the label.

neutron 6
proton 6
electron 6

6. Carbon is #6. (KAR-ben)
- Put a sheet and the label for carbon next to boron.
  - A carbon atom has six neutrons.
  - How many protons and electrons does it have? Remember boron had 5. (5+1 = 6)
- Construct a marshmallow carbon atom and write the number of protons and electrons on the label.

Does it seem simple to make one type of atom and then the next? Well, it is. You are using marshmallows to make each type of atom. Every time you make an atom, you use the same kind of marshmallow for the protons and the same kind for the neutrons and the same kind for the electrons. If you could see something as small as a real atom, you would see that all electrons are the same as each other. All protons are the same as each other and all neutrons are the same as each other. What makes one type of atom different from another is the number of protons, neutrons, and electrons that it has. Amazing, isn't it?

neutron 7
proton 7
electron 7

7. Nitrogen is #7. (NYE-truh-gen)
- Put a sheet and the label for nitrogen next to carbon.
  - Nitrogen has seven neutrons.
  - How many protons and electrons does nitrogen have? Carbon had six of each. (7)
- Construct a marshmallow nitrogen atom and write the number of protons and electrons on the label.

neutron 8
proton 8
electron 8

8. Oxygen is #8. (OK-si-jen)
- Put a sheet and the label for oxygen next to nitrogen.
  - Oxygen has eight neutrons.
  - How many protons and electrons does oxygen have? Nitrogen had seven of each. (8)
- Construct a marshmallow oxygen atom and write the number of protons and electrons on the label.

neutron 10
proton 9
electron 9

9. Fluorine is #9. (FLOOR-een)
- Put a sheet and the label for fluorine next to oxygen.
  - Fluorine has ten neutrons.
  - How many protons and electrons does fluorine have? (9)
- Construct a marshmallow fluorine atom and write the number of protons and electrons on the label.

neutron 10
proton 10
electron 10

10. Neon is #10. (NEE-on)
- Put a sheet and the label for neon next to fluorine.
  - Neon has 10 neutrons.
  - How many protons and electrons does neon have? (10)
- Construct a marshmallow neon atom and write the number of protons and electrons on the label.

(continued on the back)

11. Move the helium atom in the first row over the top of the neon atom. (There should be a big space between hydrogen and helium.)

12. Weigh the marshmallow nucleus (protons and neutrons) of your neon atom on the scale. Now add the electrons for neon to the scale. Did the electrons make much of a difference to the overall weight? Where is almost all of the mass of the marshmallow neon atom? In real atoms (not just in marshmallow ones), almost all the mass is in the nucleus, too.

Now that you are an expert at making the different types of atoms, let's talk about energy levels. Leave the atoms you have made out; you will need them for this next section.

<u>Aloud Part 2 - Energy Levels:</u>
Can you find the energy level for helium on your "Parts of an Atom" poster? Remember, an atom's electrons go in its energy levels. How many electrons are in the energy level of helium on your poster? (2) Most atoms have more than one energy level. The energy levels have very strict rules about how many electrons can fit in each one. Think of it like musical chairs. There are only so many "seats" in each energy level, and each seat fits only one electron. Any more electrons in the atom have to go in the next energy level. The first energy level is the one closest to the nucleus. Only two electrons fit in this energy level. When the "music" stops at the first energy level, there can only be one or two electrons in it. The first energy level is always the first one to fill up.

Show the Atomic Energy Levels Diagram on the next page to your students, or recreate the diagram on a chalkboard.

Think of the nucleus of an atom as a planet and the electrons as moons. Hydrogen and helium have one energy level. Their electrons are like moons that have the same orbit. The atoms from lithium through neon have two energy levels.

13. Go back to your atoms. Put the electrons that go in the first energy level in their special "seats" in the energy level closest to the nucleus. Starting with hydrogen and ending with neon, put one to two electrons in the energy level closest to the nucleus.

That leaves most of the atoms with electrons that are not yet in an energy level. The second energy level can fit UP TO eight electrons in it. That is a lot of moons in one orbit!

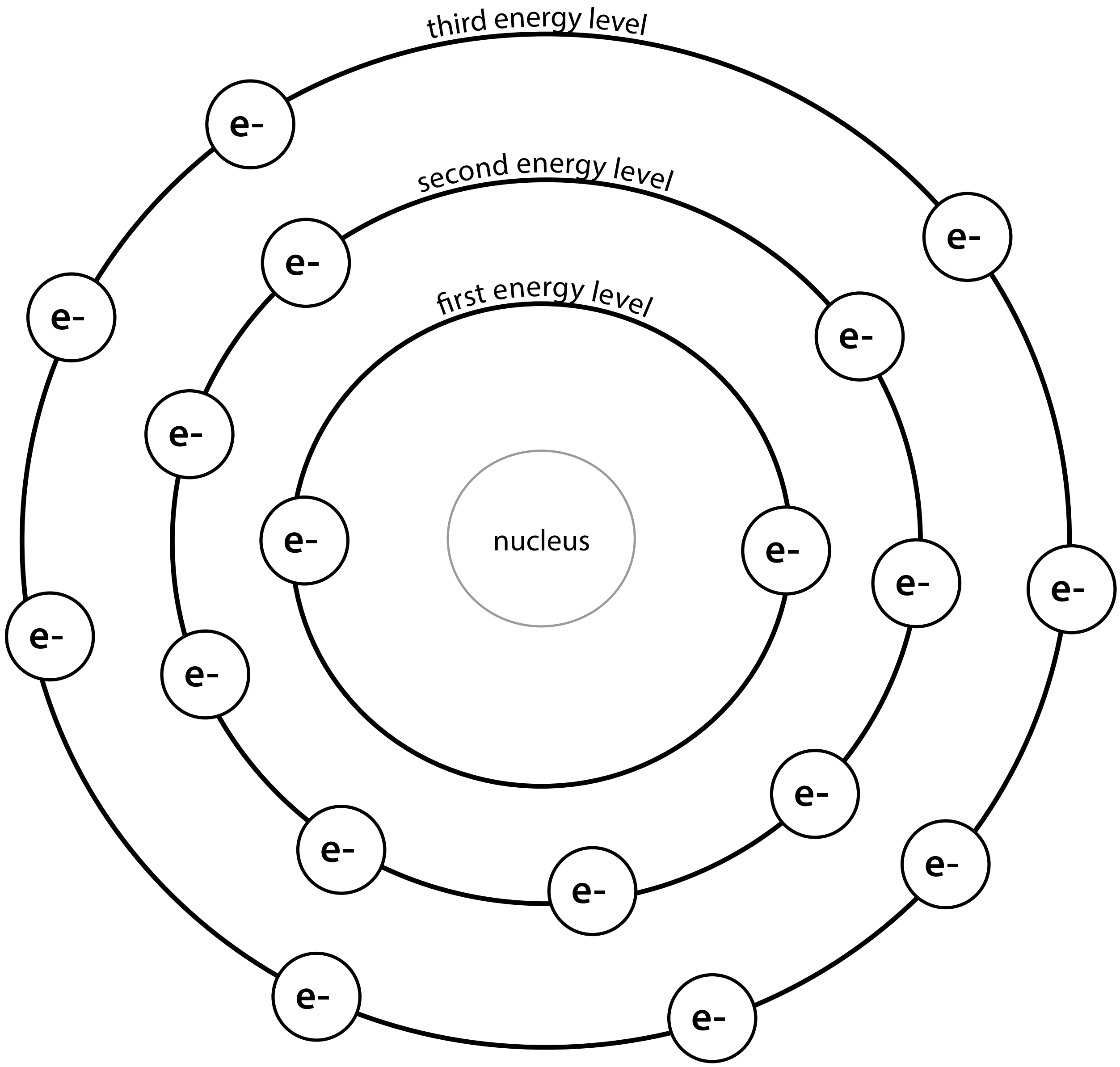
14. Go to your marshmallow atoms and put all the remaining electrons in the second energy level around each nucleus. Do not bunch the electrons up; they should be spread evenly around the energy level.

Instructor's Note:

- Every type of atom has one and only one amount of protons. That is what defines the type of atom. The number of electrons can change as a function of bonding. In the neutral state, as represented on the periodic table and with your student's marshmallow atoms, the number of electrons equals the number of protons. The number of neutrons, however, can vary without changing the type of atom. In fact, every type of naturally occurring element has a variable amount of neutrons. These atoms are called isotopes. Isotopes are atoms with the same number of protons but different numbers of neutrons. Every type of atom has isotopes. Here and throughout this book, only the most commonly occurring number of neutrons is used.

Atomic Energy Levels Diagram

Maximum Number of Electrons



NAME ________________________________ DATE ____________________

Types! Lab: The First Ten

Hydrogen 1
neutron 0
proton 1
electron 1

Carbon 6
neutron 6
proton __
electron __

Helium 2
neutron 2
proton 2
electron 2

Nitrogen 7
neutron 7
proton __
electron __

Lithium 3
neutron 4
proton 3
electron __

Oxygen 8
neutron 8
proton __
electron __

Beryllium 4
neutron 5
proton __
electron __

Fluorine 9
neutron 10
proton __
electron __

Boron 5
neutron 6
proton __
electron __

Neon 10
neutron 10
proton __
electron __