CHAPTER RESOURCES

Chapter 4
Understanding the Atom

Includes:

LEVELED ASSESSMENT

Chapter Review

Chapter Tests

- Test A (Below Level) BL
- Test B (On Level) OL
- Test C (Advanced Learner) AL

LABS

For leveled labs, use the LabManager *CD-ROM.*

Lab worksheets from Student Edition Labs

- MiniLab
- Lab: Version A (Below Level) BL
- Lab: Version B (On Level) OL (Advanced Learner) AL

UNIVERSAL ACCESS/LEVELED RESOURCES

Target Your Reading

Chapter Content Mastery English (Below Level) BL

Chapter Content Mastery Spanish (Below Level) BL

Reinforcement (On Level) OL

Enrichment (Advanced Learner) AL

READING SUPPORT

Content Vocabulary

Chapter Outline

TEACHER SUPPORT AND PLANNING

Chapter Outline for Teaching

Teacher Guide and Answers

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Teacher Approval Initials

Date of Approval

Student Lab/Activity Safety Form

Student Name: ______________________

Date: ______________________

Lab/Activity Title: ______________________

In order to show your teacher that you understand the safety concerns of this lab/activity, the following questions must be answered after the teacher explains the information to you. You must have your teacher initial this form before you can proceed with the activity/lab.

1. How would you describe what you will be doing during this lab/activity?

2. What are the safety concerns associated with this lab/activity (as explained by your teacher)?

- ______________________
- ______________________
- ______________________
- ______________________
- ______________________

3. What additional safety concerns or questions do you have?

Adapted from Gerlovich, et al. (2004). The Total Science Safety System CD, JaKel, Inc. Used with Permission.

Name ______________________ Date ______________ Class __________

MiniLab How big are the particles in an atom?

CHAPTER 4

Protons and neutrons are about 1,836 times heavier than an electron. How can you model the proportions?

Procedure

1. Read and complete a lab safety form.
2. To represent a proton, measure 1,836 mL of **water** into a **large container.** Label the container *proton*.
3. To represent a neutron, label **another large container** *neutron*. Fill it with 1,836 mL of water.
4. Measure 1 mL of water into a **teaspoon.** This represents the electron.
5. Record what you see in the *Data and Observations* section below.

Data and Observations

Analysis

1. **Assess** whether this model is a good comparison of protons and neutrons. What is good about it? What is negative about it? How would you improve it?

____

____

____

2. **Calculate** the mass of water that should be used for an atom of lithium. Lithium has 3 protons, 4 neutrons, and 3 electrons. Use the chart below to show your work.

Number of Protons × 1,836 mL	Number of Neutrons × 1,836 mL	Number of Electrons × 1 mL	Total Mass of Water

Name ____________________ Date ____________ Class ________

MiniLab How do electrons move?

CHAPTER 4

Procedure

1. Complete a lab safety form.
2. Draw a straight line down the center of a **10-cm × 10-cm block of foam** with a **ruler.**
3. Break **20 toothpicks** in half. Poke the halves into the foam so they are like the nucleus of an atom.
4. Use **round, dried peas** as electrons. Aim and flick the peas down the center line on the block.
5. Make a diagram in the *Data and Observations* section below to show where the electrons came out. Use a **protractor** to measure the angle the electrons made compared to the center line, which is the path they would have followed if they did not hit any atoms.

Data and Observations

Analysis

1. **Describe** how your arrangement of toothpicks was like the nuclei of atoms in a block of metal. Why did the toothpicks represent just the nuclei instead of the whole atoms?

____

____

2. **Describe** problems you had with this experiment.

____

____

Name ______________________ Date ______________ Class ________

Lab

Build an Atom

CHAPTER 4
VERSION A

Problem You have learned about the people who developed a picture of what atoms look like and you have learned the parts of an atom. Now, create an atom. Use craft materials to design and produce your own model of an atom.

Materials

dried peas
small balloons
medium balloons
large balloons
craft wire
small pompoms
jelly beans
glue

Safety Precautions

Procedure

Directions: *Check the boxes below as you complete each step of the procedure.*

Select a Model

☐ **1.** Read and complete a lab safety form.

☐ **2.** Choose an element.

☐ **3.** Draw an atomic structure diagram for that element in your Science Journal.

Hint: *The atomic structure should include the number of protons, neutrons, and electrons. You can find this information in a periodic table.*

Remember that the atomic number tells the number of protons in the element. The number of protons and the number of electrons is always the same.

☐ Draw the protons and neutrons located in the nucleus, and the electrons located outside the nucleus.

☐ **4.** List everything you know about protons, neutrons, electrons, and their behavior.

Plan Your Model

☐ **5.** How will you model the atom? Decide what materials you will use for the atom.

☐ How will you arrange the electrons outside the nucleus? Do you want to put electrons on wire or in balloon clouds?

Hint: *Think about what you know about electron clouds. How do electrons move? Where are most electrons likely to be located?*

☐ What type of objects will you use to show protons, electrons, and neutrons?

☐ **6.** Make sure your teacher has approved your model before you proceed.

Build Your Model

☐ **7.** Create your atomic model.

☐ **8.** Show and discuss your model with your classmates.

Lab: Version A CONTINUED

Analyze and Conclude

1. **Describe** how you represented the nucleus in your model. Do you think this worked well?

2. **Describe** how you represented electrons in your model. Explain how your model mimics how electrons behave.

3. **Write** a paragraph describing two of your classmates' models. What did you like about their models? What do you think they could have done better?

4. **Explain** how your model would work if you decided to make a smaller atom. Would another model work better? What if you tried to make a larger atom?

Lab: Version A CONTINUED

5. **Infer** How do the mass and distance ratios of your model compare with reality?

____

____

____

6. **Error Analysis** What could have been better about your model? Explain in detail how you could improve it.

____

____

____

Communicate

Peer Review With your classmates, compare and contrast your models. Discuss the best features of each model and ways that each might be improved. Vote on which model does the best job representing:

- particles of the nucleus
- electrons
- size of the nucleus
- distance of electrons from the nucleus
- movement of electrons
- electron levels

Be prepared to defend your vote for each category. Can you explain why you voted the way you did?

Name ______________________ Date ______________ Class ________

Lab

Build an Atom

CHAPTER 4
VERSION B

Problem You have learned about the people who developed a picture of what atoms look like and you have learned the parts of an atom. Now, create an atom. Use craft materials to design and produce your own model of an atom.

Materials

dried peas
small balloons
medium balloons
large balloons
craft wire
small pompoms
jelly beans
glue

Safety Precautions

Procedure

Directions: *Check the boxes below as you complete each step of the procedure.*

Select a Model

☐ **1.** Read and complete a lab safety form.

☐ **2.** Choose an element.

☐ **3.** Draw an atomic structure diagram for that element in your Science Journal.

☐ **4.** List everything you know about protons, neutrons, electrons, and their behavior.

Plan Your Model

☐ **5.** How will you model the atom? Decide what materials you will use for the atom. How will you arrange the electrons outside the nucleus? Do you want to put electrons on wire or in balloon clouds? What type of objects will you use to show protons, electrons, and neutrons?

☐ **6.** Make sure your teacher has approved your model before you proceed.

Build Your Model

☐ **7.** Create your atomic model.

☐ **8.** Show and discuss your model with your classmates.

Analyze and Conclude

1. **Describe** how you represented the nucleus in your model. Do you think this worked well?

____

____

____

2. **Describe** how you represented electrons in your model. Explain how your model mimics how electrons behave.

____

____

____

Lab: Version B CONTINUED

3. **Write** a paragraph describing two of your classmates' models. What did you like about their models? What do you think they could have done better?

4. **Explain** how your model would work if you decided to make a smaller atom. Would another model work better? What if you tried to make a larger atom?

5. **Infer** How do the mass and distance ratios of your model compare with reality?

6. **Error Analysis** What could have been better about your model? Explain in detail how you could improve it.

Going Further

Challenge

7. Pretend a student from another class created a model of carbon. He smashed six white mini marshmallows together in the center of the model. Around the mini marshmallows, he strung six large marshmallows on a piece of circular wire. **Assess** this model of carbon. Suggest ways the model could be improved.

Lab: Version B CONTINUED

8. **Decide** which aspects of the atom were most difficult to model. Determine what made this problematic.

______

______

______

9. **Suppose** you were to model an isotope of your element. How might your model change?

______

Extension

You have learned that scientists have determined that protons, neutrons, and electrons are small particles that comprise an atom. Did you know there are even smaller particles in an atom? Scientists are researching these now using tools such as a particle accelerator. Scientists have named two types of subatomic particles leptons and quarks. Research the properties of these two types of subatomic particles. Write a paragraph telling the properties of each type.

Communicate

Peer Review With your classmates, compare and contrast your models. Discuss the best features of each model and ways that each might be improved. Vote on which model does the best job representing:

- particles of the nucleus
- electrons
- size of the nucleus
- distance of electrons from the nucleus
- movement of electrons
- electron levels

Be prepared to defend your vote for each category. Can you explain why you voted the way you did?

Name ______________________ Date ______________ Class ________

Target Your Reading — Understanding the Atom

CHAPTER 4

Use this to focus on the main ideas as you read the chapter.

1. **Before you read** the chapter, respond to the statements below on your worksheet or on a numbered sheet of paper.
   - Write an **A** if you **agree** with the statement.
   - Write a **D** if you **disagree** with the statement.
2. **After you read** the chapter, look back to this page to see if you've changed your mind about any of the statements.
   - If any of your answers changed, explain why.
   - Change any false statements into true statements.
   - Use your revised statements as a study guide.

Before You Read A or D	Statement	After You Read A or D
	1. An atom is the smallest particle of matter.	
	2. The idea of an atom was already being discussed by the Greeks in 400 B.C.	
	3. Dalton's atom is a uniform sphere of matter.	
	4. Thomson discovered a positively charged particle called an electron.	
	5. Rutherford demonstrated that the atom was mostly empty space.	
	6. In the current model of the atom, the nucleus of the atom is at the center of an electron cloud.	
	7. A filled outer energy level means that an atom will combine with other atoms.	
	8. You can determine the number of protons, neutrons, and electrons from the mass number.	
	9. Isotopes of the same element have the same number of protons but different numbers of electrons.	

Name ______________________ Date ______________ Class __________

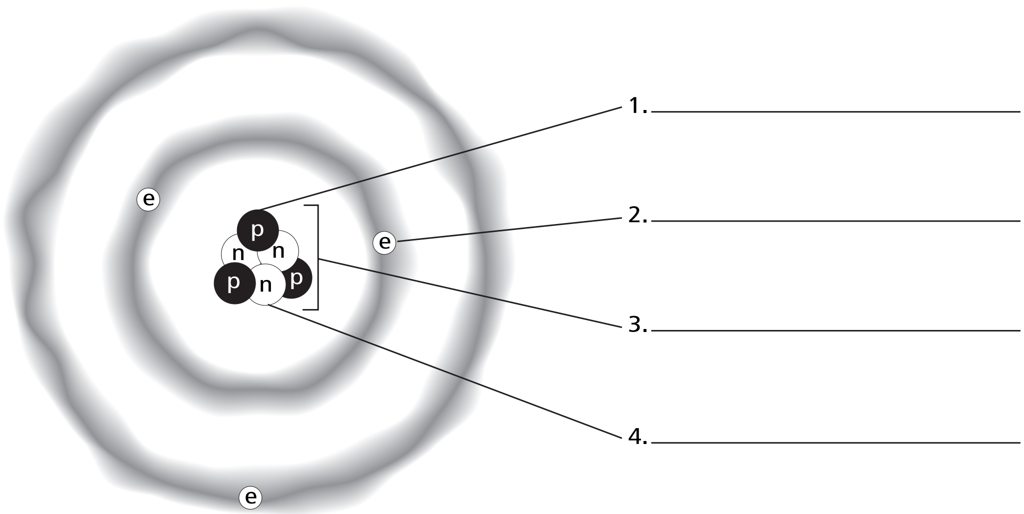
Chapter Content **Mastery**

Atoms—Basic Units of Matter

CHAPTER 4
LESSON 1

Directions: *Study the following diagram. Then label each part using the correct term from the list.*

electron **neutron** **nucleus** **proton**



Directions: *Complete the following sentences using the terms listed below.*

atoms **electron** **matter** **neutron** **proton**

5. ______________ is anything that has mass and takes up space.

6. Most types of matter are made up of small particles called ______________.

7. A(n) ______________ is a particle with a positive charge.

8. A(n) ______________ is a particle with no charge at all.

9. A (n) ______________ is a particle with a negative charge.

Directions: *Match the scientist with his contribution to the atomic theory.*

Dalton **Democritus** **Lavoisier** **Proust**

10. ______________ was the first to use the term *atom*. He thought atoms were "indivisible" small, solid spheres.

11. ______________ proposed the law of conservation of mass, which states that the mass of the products always equals the mass of what you started with.

12. ______________ proposed the law of definite proportions, which states that pure compounds always contain the same elements in the same proportion by mass.

13. ______________ invented symbols for known elements.

Name ____________________ Date ______________ Class __________

Chapter Content **Mastery**

Discovering Parts of the Atom

CHAPTER 4
LESSON 2

Directions: *Number the following steps that led to our current understanding of the atom in the order in which they occurred.*

_______ **1.** J. J. Thomson discovered the existence of the electron.

_______ **2.** John Dalton thought that each type of matter is made up of only one type of atom.

_______ **3.** James Chadwick discovered neutrons in the nucleus.

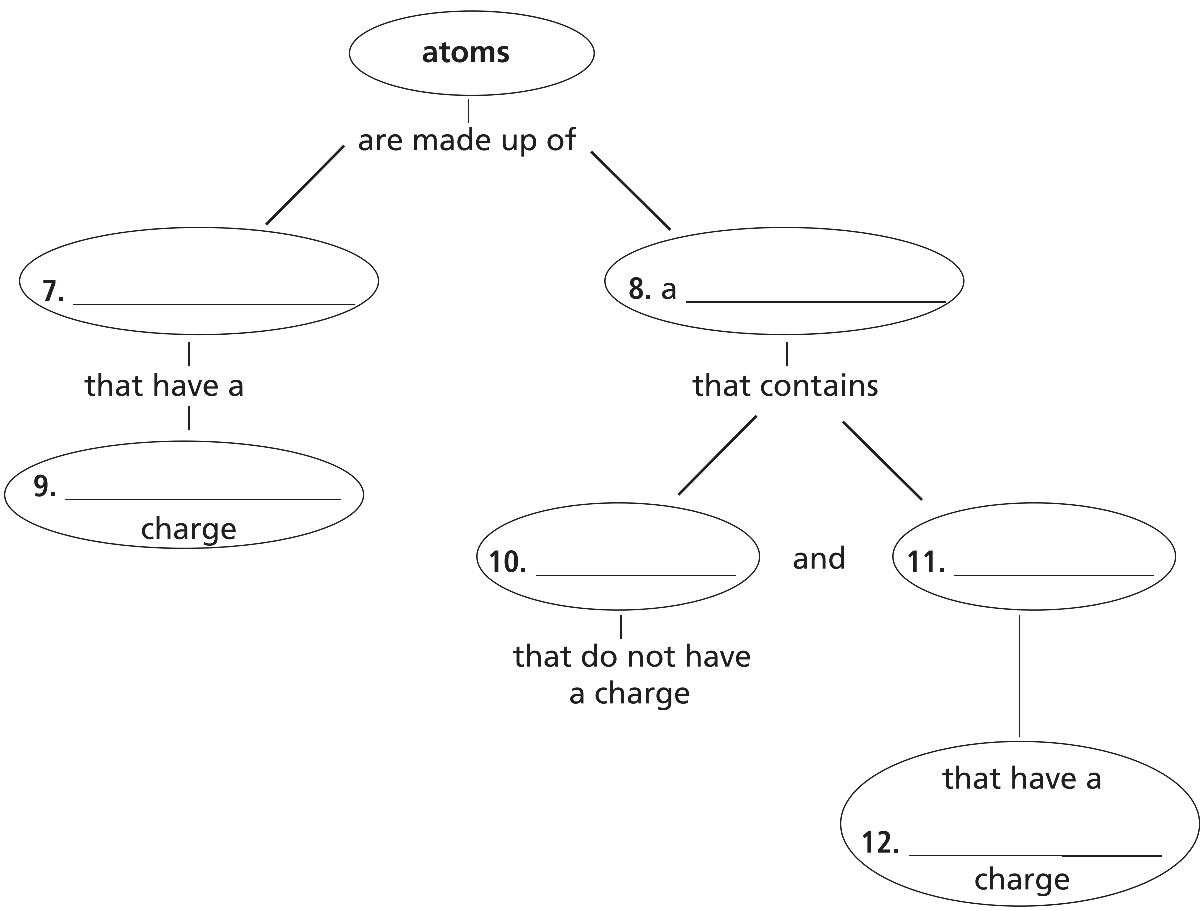
_______ **4.** Niels Bohr improved the atom model by including electron energy levels.

_______ **5.** Ernest Rutherford suggested that electrons are scattered in the mostly empty space around an atom's nucleus.

_______ **6.** Democritus devised the theory that the universe is composed of tiny bits of matter he called atoms.

Directions: *Complete the concept map using the terms listed below.*

electrons **negative** **neutrons** **nucleus** **positive** **protons**



Name ______________________ Date ______________ Class ________

Chapter Content **Mastery**

Elements, Isotopes, and Ions—How Atoms Differ

CHAPTER 4
LESSON 3

Directions: *Complete each sentence by filling in the blank with one of the terms provided.*

atomic number	**average atomic mass**	**column**	**compounds**
electrons	**element**	**ion**	**isotopes**
neutrons	**nucleus**	**periodic table**	**protons**

1. A(n) ________________________ is a material that contains only one type of atom.

2. The ________________________ is equal to the number of protons.

3. The ________________________ is equal to the mass of the protons, neutrons, and electrons.

4. The ________________________ is a tool scientists use to organize the elements and to understand the relationships between their chemical properties.

5. In the periodic table, elements are arranged in increasing numerical order by the number of ________________________ found in the nucleus of each.

6. Elements in the same ________________________ of the periodic table have similar chemical properties.

7. Atoms of the same element have the same number of protons. Atoms of the same element might have different numbers of ________________________.

8. Atoms of the same element that have different numbers of neutrons are called ________________________.

9. An element's atomic number is the number of protons in its ________________________.

10. Neutral atoms have equal numbers of protons and ________________________.

11. An atom that has an electrical charge from gaining or losing electrons is called a(n) ________________________.

12. Positive and negative ions attract each other and form chemical ________________________.

Nombre ____________________ Fecha ____________ Clase ________

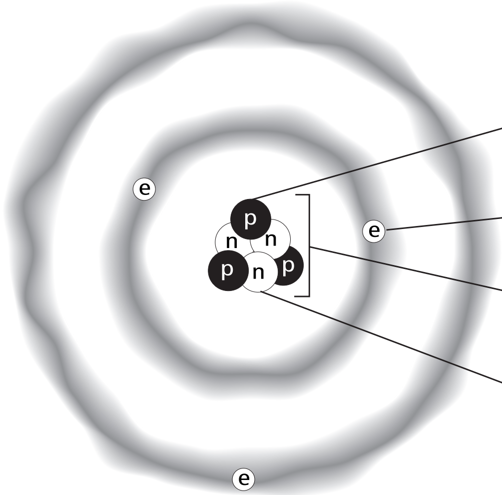
Dominio del contenido

Los átomos—las unidades básicas de la materia

CAPÍTULO 4
LECCIÓN 1

Instrucciones: *Estudia el siguiente diagrama. Entonces etiqueta cada parte usando el término correcto de la lista.*

electrón **neutrón** **núcleo** **protón**



1. ____________________
2. ____________________
3. ____________________
4. ____________________

Instrucciones: *Completa las siguientes oraciones usando los términos abajo.*

átomos **electrón** **materia** **neutrón** **protón**

5. ____________________ es algo que tiene masa y ocupa espacio.

6. La mayoría de la materia es hecha de partículas chicas que se llaman ____________________.

7. Un(a) ____________________ es una partícula con una carga positiva.

8. Un(a) ____________________ es una partícula que no tiene una carga.

9. Un(a) ____________________ es una partícula con una carga negativa.

Instrucciones: *Coincide el científico con su contribución a la teoría atómica.*

Dalton **Democritus** **Lavoisier** **Proust**

10. ____________________ fue el primero para usar el término "átomo." Él pensaba que los átomos eran esferas chicas, sólidas y "indivisibles."

11. ____________________ propuso la ley de la conservación de la masa, que indica que la masa de los productos siempre igual a la masa con la que comenzaste.

12. ____________________ propuso la ley de proporciones definitivas, que indica que los compuestos puros siempre contienen los mismos elementos en la misma proporción por la masa.

13. ____________________ inventó los símbolos para los elementos conocidos.

Dominio del contenido

Descubriendo las partes del átomo

CAPÍTULO 4
LECCIÓN 2

Instrucciones: *Ordena los siguientes pasos que llevaron a nuestra comprensión actual del átomo en el orden en que ocurrieron.*

_________ **1.** J. J. Thomson descubrió la existencia del electrón.

_________ **2.** John Dalton pensó que cada clase de materia está hecha de solamente una clase de átomo.

_________ **3.** James Chadwick descubrió los neutrones en el núcleo.

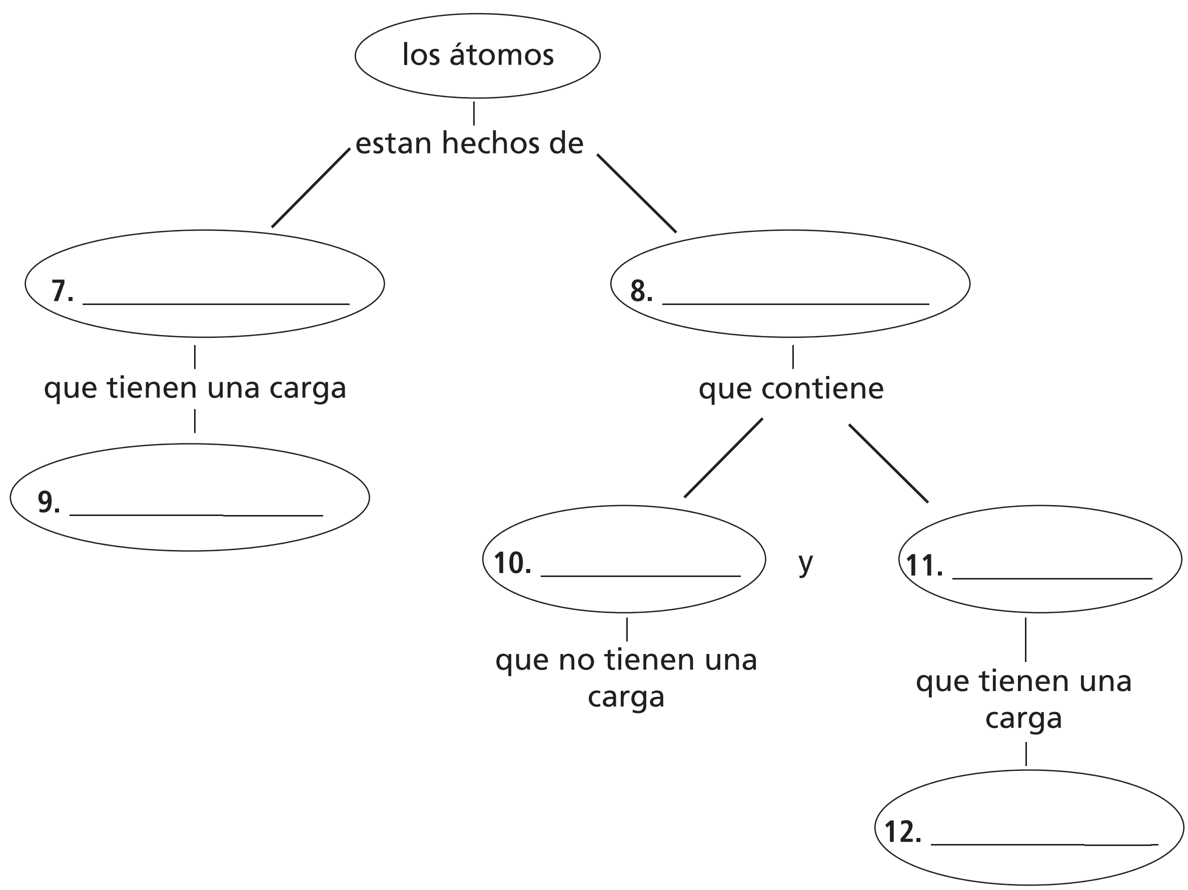
_________ **4.** Niels Bohr mejoró el modelo del átomo incluyendo los niveles de la energía electrónica.

_________ **5.** Ernest Rutherford sugirió que los electrones están sueltos en el espacio que está casi vacío alrededor del núcleo del átomo.

_________ **6.** Democritus desarrollo la teoría que el universo está compuesto de pedacitos pequeños de materia que él llamó átomos.

Instrucciones: *Completa el mapa de conceptos usando los términos abajo.*

electrones **negativa** **neutrones** **núcleo** **positiva** **protones**



Nombre ______________________________ Fecha ______________ Clase ________

Dominio del contenido

CAPÍTULO 4
LECCIÓN 3

Instrucciones: *Completa cada oración usando los siguientes términos.*

columna	**compuestos**	**electrónes**	**elemento**
ion	**isótopos**	**masa atómica media**	**neutrones**
núcleo	**número atómico**	**protones**	**tabla periódica**

1. Un(a) ______________________ es un material que contiene solamente una clase de átomos.

2. El (La) ______________________ es igual al número de protones.

3. El (La) ______________________ es igual a la masa de los protones, los neutrones y los electrones.

4. El (La) ______________________ es una herramienta que los científicos usan para organizar los elementos y para entender las relaciones entre sus propiedades químicas.

5. En la tabla periódica, los elementos están ordenados en orden numérico creciente por el número de ______________________ que se encuentran en el núcleo de cada uno.

6. Los elementos en la misma ______________________ de la tabla periódica tienen propiedades químicas similares.

7. Los átomos del mismo elemento tienen el mismo número de protones. Los átomos del mismo elemento quizás tendrán diferentes números de ______________________.

8. Los átomos del mismo elemento que tienen diferentes números de neutrones se llaman ______________________.

9. El número atómico de un elemento es el número de los protones en su ______________________.

10. Los átomos neutrales tienen iguales números de protones y ______________________.

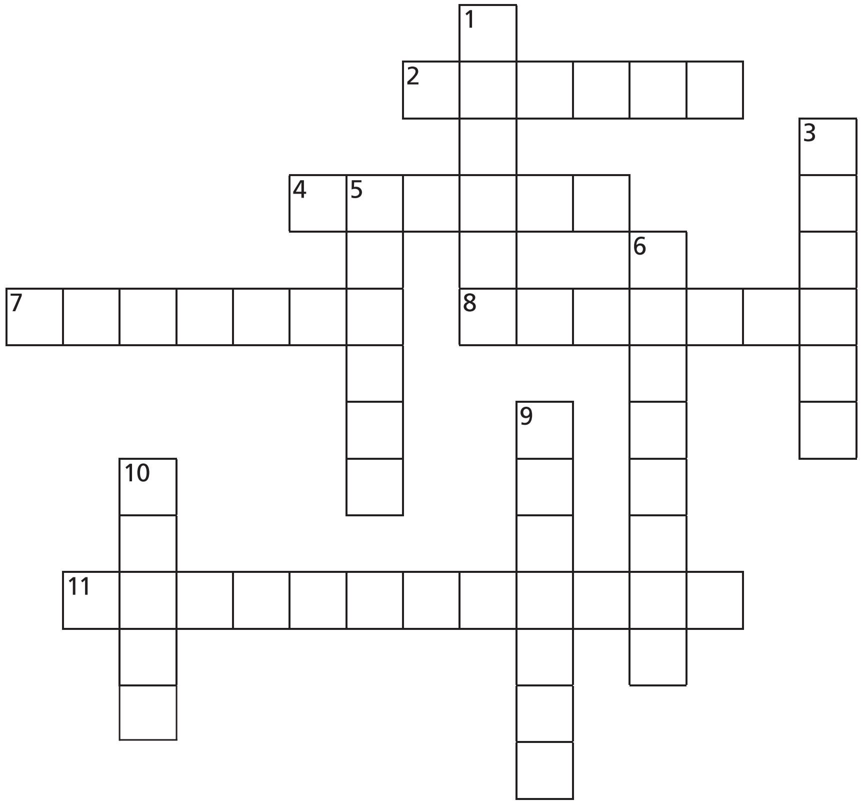
11. Un átomo que tienen una carga eléctrica por haber ganado o perdido electrones se llama un(a) ______________________.

12. Los iones positivos y negativos se atraen uno al otro y forman ______________________ químicas.

Name ______________________ Date ______________ Class ________

Reinforcement Atoms—Basic Units of Matter

CHAPTER 4
LESSON 1



Directions: *Use the clues below to complete the crossword puzzle.*

Across

2. has mass and takes up space
4. positively charged particle in the nucleus of an atom
7. made up of the same type of atoms
8. the central part of an atom that contains the protons and neutrons
11. The law of ______________________ of matter states that matter can neither be created nor destroyed.

Down

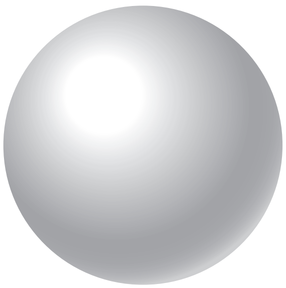
1. scientist who was the first person to use atomic symbols
3. The atoms of different elements have different ______________________ and properties.
5. Atoms of different elements combine in whole-number ______________________.
6. negatively charged particle in an atom
9. uncharged particle in the nucleus of an atom
10. Most matter on Earth is made up of these small particles.

Name ______________________ Date ______________ Class ________

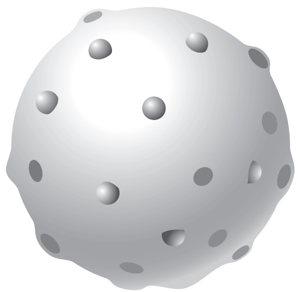
Reinforcement Discovering Parts of the Atom

CHAPTER 4
LESSON 2

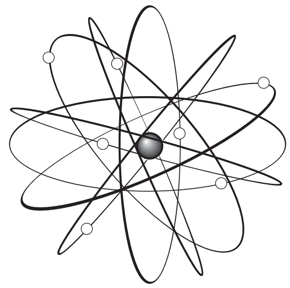
Directions: *Using the letters* A, B, C, *and* D, *label the atomic models shown below in order from the first created to the last created. Label the earliest model with the letter* A, *and the most recent model with the letter* D.



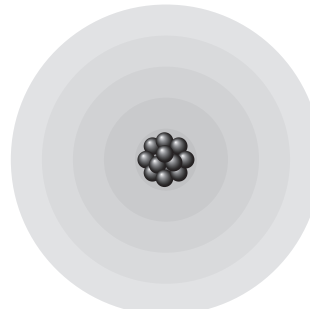
1. ______________



2. ______________



3. ______________



4. ______________

Directions: *Briefly explain one way in which each scientist added to our knowledge of the atom.*

5. Thomson ____

____

6. Rutherford ____

____

7. Bohr ____

____

Directions: *Leave each true statement as it appears. If a statement is false, rewrite it so that it is correct.*

8. If an electron is heated or electrified, it will give off light energy as it moves from a lower to a higher electron energy level.

____

____

9. Each energy level can hold an unlimited number of electrons.

____

10. Atoms with the same outer level electron pattern have similar properties.

____

11. Atoms that have a full outer energy level combine with other atoms.

____

Name ______________________ Date ______________ Class ________

Reinforcement Elements, Isotopes, and Ions—How Atoms Differ

CHAPTER 4
LESSON 3

Directions: *Circle the two terms in each group that are related. Then explain why the terms are related.*

1. electron, neutron, proton ____________________

2. atom, amu, element ____________________

3. atomic number, proton, neutron ____________________

4. atomic mass, compound, isotope ____________________

5. electron, ion, neutron ____________________

6. atomic number, isotope, radioactive ____________________

7. compound, ion, proton ____________________

8. energy level, neutron, spectral line ____________________

Directions: *Circle the term that correctly completes each sentence.*

9. The number of protons in an atom determines its (atomic number/nucleus).

10. An element's (atomic number/atomic mass) is the average mass of the different isotopes of the element.

11. A(n) (compound/element) is matter that is made up of only one type of atom.

12. (Ions/Isotopes) are atoms of the same element with different numbers of neutrons.

13. A(n) (compound/element) is a substance whose smallest unit is made up of more than one element.

14. (Ions/Isotopes) are atoms that have gained or lost electrons.

15. The (chemical symbol/periodic table) is a way of organizing the elements according to their chemical properties.

Name ______________________ Date ______________ Class ________

Enrichment Tiny Matter

CHAPTER 4
LESSON 1

Though all elements are made up of tiny atoms, and all atoms are made up of tinier protons, electrons, and neutrons, there are even smaller particles. These particles are called subatomic particles, and neutrinos are one type of subatomic particle. Just as scientists theorized about the structure of the atom and the placement of electrons within atoms, other scientists have recently hypothesized about the existence of neutrinos and conducted experiments to confirm these theories.

Three Types of Neutrinos

Trillions of neutrinos cross Earth—and move through you—every second. They have less than a fraction of the mass of an electron and they are neutral. There are three types of neutrinos: electron-neutrinos, muon-neutrinos, and tau-neutrinos. Physicists have been studying neutrinos since the 1930s. The most important discoveries are listed here.

1930 Based on observations of radioactive decay, Wolfgang Pauli hypothesizes that neutrinos exist.
1956 Clyde Cowan and Fred Reines discover neutrinos by using a nuclear reactor.
1956–57 Bruno Pontecorvo, Shoichi Sakata, and other physicists suggest that neutrinos oscillate, or change form.
1964 John Bahcall and Ray Davis propose measuring neutrinos from the Sun.
1965 Neutrinos produced in the atmosphere are first observed by Fred Reines and other physicists in a gold mine in South Africa.
1976 Scientists design new neutrino detectors in Hawaii.
1980s First massive underground instrument for neutrino detection is built 600 m underground in a salt mine near Cleveland, Ohio. An experiment begins in Kamioka, Japan in a zinc mine.
1986 The Kamioka group observes solar neutrinos.
1996 A U.S.-Japan team uses Super-Kamiokande, the largest detector ever built, to search for neutrino interactions.
1998 The Super-Kamiokande team reports oscillations, or changes in form.
1999 The Super-Kamiokande team detects a neutrino that had been produced artificially.

Directions: *Answer each question or respond to each statement.*

1. **Investigate** Use encyclopedias and other library resources to describe the first 25 years of neutrino studies. Use a separate sheet of paper.

2. **Speculate** Based on the types of neutrinos, what kinds of changes do you think the scientists observed in 1998?

____

____

3. **Hypothesize** Will the study of neutrinos change scientists' understanding of the atom? Explain on a separate sheet of paper.

Name ______________________ Date ______________ Class ________

Enrichment The Bohr Model of the Atom

CHAPTER 4
LESSON 2

After Danish physicist Niels Bohr received a doctorate from the University of Copenhagen in 1911, he worked with J. J. Thomson, the British physicist who discovered the electron. By 1912, Bohr was working with Ernest Rutherford, who developed the nuclear theory of the atom. In 1913, Bohr published his own theory about the structure of the atom.

Bohr's Proposal

Rutherford had shown that the nucleus of an atom is dense, containing most of the mass of the atom. His experiments also showed that the nucleus is small in comparison with the space occupied by the electrons, and that a lot of the space taken up by an atom is just that—empty space. Bohr proposed that the electrons in this atomic space could occupy only specific and separate energy levels as they swirl around the nucleus. He also thought that the farther away an electron is from the nucleus, the more energy the electron needs to stay in that level. Electrons are usually located in the lowest energy level available, which is called the ground state. **Figure 1** shows the hydrogen atom in its ground state.

Energy for the Jump

Bohr suggested that when an electron absorbs enough energy—for example, when it is heated to a high temperature—it moves to a higher energy level. Then the electron is in what is called an excited state. **Figure 2** shows the hydrogen atom in an excited state.

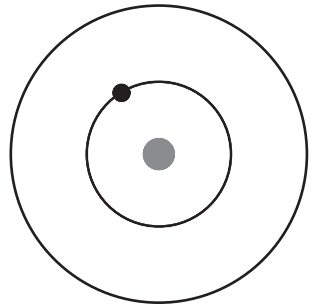


Figure 1

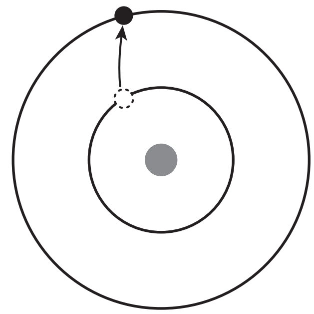


Figure 2

When the energy source is removed, the electron drops back down to the ground state and gives off all the absorbed energy in one unit. These units are specific amounts of energy. One of these units is called a quantum.

Changing Energy Levels

Bohr's theory said an electron can't exist between energy levels—like an elevator stuck between floors. If the electron has enough energy to move to another level, it does. Otherwise, it remains in the lower level.

Bohr's theory was not perfect. His calculations worked well for the hydrogen atom, which has only one electron, but they didn't work well for bigger atoms. However, Bohr's ideas helped other scientists develop what is known today as quantum mechanics, a field of physics that explains the structure and some of the behaviors of more complex atoms. This structure and behavior is explained by mathematics.

Directions: *Respond to each statement on the lines provided.*

1. **Contrast** the Bohr model of the atom with the Rutherford model.

____

____

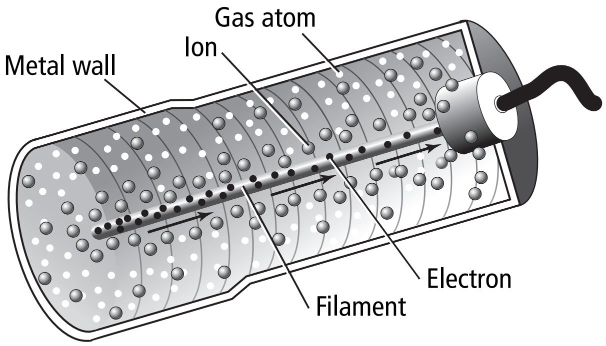
2. **Explain** why an atom absorbs or releases energy in very specific units. Use what you know about atoms and energy levels.

____

____

Enrichment The Geiger Counter

CHAPTER 4
LESSON 3



Early in the twentieth century, German physicist Hans Geiger developed an instrument to detect radiation from various isotopes. Prospectors can use Geiger counters to detect uranium and other radioactive elements. Scientists and other professionals use Geiger counters to detect the presence of radiation and to measure the level of the radiation. People who work with radiation can use a Geiger counter as a safety check.

A Basic Design

Geiger counters come in many different sizes and shapes, but the essential design is always the same. A typical Geiger counter consists of a cylindrical metal tube filled with an inert gas that can be readily ionized. (Inert gases have full outer energy levels.) Stretched along this tube is a filament, or fine wire. The filament and the metal wall serve as electrodes. The filament is positively charged, and the wall is negatively charged.

An electric field exists between the filament and the wall of the tube. However, because the inert gas does not conduct electricity, an electric current is produced only when the inert gas is ionized. Radiation entering the chamber of the Geiger counter collides with the gas atoms, causing the inert gas to lose electrons. The negatively charged electrons rush toward the positively charged filament. These electrons free more electrons, resulting in an avalanche of ions.

The Sound of Electric Pulse

The electrons spread out along the central filament and create an electric pulse. The electric pulse is counted by a meter. Even one particle results in a full pulse on the filament. Therefore, when the level of radiation increases, the clicking becomes louder and more frequent. The familiar static and clicking sounds identified with a Geiger counter result from the meter counting the pulses created by the electrons.

Directions: *Answer each question or respond to each statement on the lines provided.*

1. **Distinguish** Name two important properties of the gas used in the chamber of a Geiger counter and describe why they are important.

____

____

2. **Interpret** What causes the atoms in the chamber to ionize?

____

3. If you were a worker in a nuclear power plant, you would be required to wear a radiation-sensitive badge to measure your exposure to radiation over time. **Theorize** about how this type of badge works.

____

____

Name ______________________ Date ______________ Class __________

Content Vocabulary — Understanding the Atom

CHAPTER 4

Directions: *Write* T *or* F *on the line in front of each definition. If the definition is false, write the term that correctly matches the definition on the blank line after the statement.*

atom	**atomic number**	**average atomic mass**	**electromagnetic spectrum**
electron	**electron cloud**	**element**	**energy level**
ion	**isotope**	**mass number**	**neutron**
nucleus	**proton**	**spectral line**	

_______ **1.** A(n) **element** is a small particle that makes up all matter. ____________________

_______ **2.** An element's **average atomic mass** is the weighted average of the masses of all isotopes of the element. ____________________

_______ **3.** The **electromagnetic spectrum** is the entire range of electromagnetic waves with different frequencies and wavelengths. ____________________

_______ **4.** A(n) **ion** is a negatively charged particle that moves in the space surrounding the nucleus. ____________________

_______ **5.** A(n) **spectral line** indicates where the electrons are most likely to be found in an atom. ____________________

_______ **6.** A(n) **element** is a pure substance that can be identified by the number of protons in the nucleus of its atoms. ____________________

_______ **7.** A(n) **electron cloud** is a distance from the nucleus with a specific energy in which an electron can move. ____________________

_______ **8.** A(n) **isotope** is an atom that no longer is neutral because it has gained or lost electrons. ____________________

Name ______________________ Date ______________ Class __________

Content **Vocabulary** CONTINUED

atom	**atomic number**	**average atomic mass**	**electromagnetic spectrum**
electron	**electron cloud**	**element**	**energy level**
ion	**isotope**	**mass number**	**neutron**
nucleus	**proton**	**spectral line**	

_________ **9.** Atoms of the same element that contain different numbers of neutrons are called **isotopes**. ______________________

_________ **10.** An atom's **atomic number** is the sum of the number of protons and neutrons it has. ______________________

_________ **11.** The **neutron** is a region that is located at the center of an atom and contains most of the atom's mass. ______________________

_________ **12.** The neutral particle located in the nucleus is a(n) **proton**. ______________________

_________ **13.** The positively charged particle located in the nucleus is a(n) **proton**. ______________________

_________ **14.** The **spectral line** is the light pattern observed after the light energy from heated elements passes through a prism. ______________________

_________ **15.** The number of protons is the **atomic number**. ______________________

Name ______________________ Date ______________ Class __________

Chapter Review — Understanding the Atom

CHAPTER 4

Part A. Vocabulary Review

Directions: *Identify the item in Column II that matches the description in Column I by writing the correct letter in the space provided.*

_____ **1.** matter that is made up of only one type of atom

_____ **2.** a negatively charged particle that orbits the nucleus of an atom

_____ **3.** a positively charged particle that is present in the nucleus of an atom

_____ **4.** an uncharged particle in the nucleus of an atom

_____ **5.** region around the nucleus in which the electrons move about

_____ **6.** the number of protons in the nucleus of an element's atom

_____ **7.** a wavelength pattern of visible light produced when elements are heated or electrified

_____ **8.** the number of neutrons plus protons in the nucleus of an atom

_____ **9.** the weighted average mass of the mixture of the isotopes for an element

_____ **10.** small particles that make up matter

_____ **11.** the massive part of an atom that contains protons and neutrons

_____ **12.** an atom that has lost or gained electrons

_____ **13.** paths around the nucleus that electrons follow

_____ **14.** the entire range of electromagnetic waves with different frequencies

_____ **15.** atoms of the same element that have different numbers of neutrons

A. atoms

B. atomic number

C. average atomic mass

D. electromagnetic spectrum

E. electron

F. electron cloud

G. element

H. energy levels

I. ion

J. isotopes

K. mass number

L. nucleus

M. neutron

N. proton

O. spectral lines

Chapter **Review** CONTINUED

Part B. Concept Review

Directions: *Draw the Bohr model of an atom below. Label the parts of the atom using the terms and numbers below. Indicate which parts have a* negative, positive, *or* neutral charge. *Use your diagram to answer questions 17–20.*

16. Current Atomic Model

Terms:
6 electrons
7 neutrons
1 nucleus
7 protons

17. Examine What is the atomic number of your atom? ______________________

18. Use the chart to the right to calculate the atomic mass of the atom you drew. ____________________

19. Decide Is your atom model an ion? **Yes** or **No**
If yes, what is the charge of the ion?

____

Particle	Mass (amu)
Proton	1.007316
Neutron	1.008701
Electron	0.000549

Directions: *Choose the correct answer for each question.*

_______ **20.** Two atoms of hydrogen always combine with one atom of oxygen to form water.

This is an example of ______________________.

A. atomic mass **B.** periodic table laws
C. the law of definite proportions **D.** the law of conservation of mass

_______ **21.** All atoms of a particular element always have the same number of ______________________.

A. protons **B.** electrons **C.** neutrons **D.** neutrinos

_______ **22.** ______________________ is anything that has mass and takes up space.

A. Matter **B.** An atom **C.** A nucleus **D.** An electron

_______ **23.** ______________________ developed a model called the atomic theory of matter.

A. Dalton **B.** Thomson **C.** Rutherford **D.** Democritus

_______ **24.** Atoms with the same number of electrons in their outer energy level have ______________________.

A. similar properties **B.** the same mass unit
C. the same atomic mass **D.** the same atomic number

Chapter Outline — Understanding the Atom

CHAPTER 4

Lesson 1: Atoms—Basic Units of Matter

A. What is the current atomic model?

1. ________________________ is anything that has mass and takes up space.

2. A(n) ________________________ is a small particle that makes up all matter.

3. Atoms are mostly ________________________ space surrounding a massive central region of the atom called the ________________________.

4. Atoms contain ________________________ kinds of particles, two in the ________________________, and one outside the center of the atom.

a. In an atom's nucleus, positively charged particles are ________________________.

b. A(n) ________________________ is a neutral particle located in the nucleus of an atom.

c. ________________________ are negatively charged particles that move in the space outside an atom's nucleus.

5. An electron has about ________________________ the mass of a neutron or protron.

B. Is there historical evidence of atoms?

1. The Greek philosopher ________________________ coined the word *atom,* based on the Greek word *atoma,* meaning "indivisible."

a. Democritus proposed that atoms were small, ________________________ spheres.

b. The atom as Democritus described it was ________________________, meaning it was the smallest possible piece of matter that could not be cut into smaller pieces.

2. The French scientist Antoine ________________________ conducted experiments that led to the law of conservation of ________________________. It says that in any chemical reaction, the mass of the products of the reaction will always be equal to the mass of the materials at the beginning of the reaction.

3. The law of ________________________, uncovered by French chemist J. L. Proust, states that pure compounds always contain the same elements in the same proportions by mass.

4. English schoolteacher and scientist ______________ did many experiments on gases that led to a new and more complete model of the atom.

a. All ______________ is made up of atoms.

b. Atoms are neither ______________ nor ______________ in chemical reactions.

c. ______________ of different elements combine in whole-number ratios.

d. Each element is made of ______________ type of atom.

e. The atoms of different elements have different ______________ and ______________.

5. Dalton used ______________ to represent different elements, making it easier to write and communicate about the elements.

Lesson 2: Discovering Parts of the Atom

A. How were electrons discovered?

1. In 1897, English scientist ______________ discovered electrons while doing an experiment to see how ______________ currents affected cathode rays.

2. J. J. Thomson proposed a new ______________ model to explain his observations: a solid sphere through which ______________ charge was spread evenly.

B. Rutherford—Discovering the Nucleus

1. When two students of Ernest Rutherford shot ______________ particles through gold foil, most particles passed straight through the foil, but some were scattered or even bounced ______________.

2. Rutherford interpreted the unexpected results to mean that the alpha particles were hitting something with a ______________ charge and a relatively large ______________.

3. Based on this information and further experiments, Rutherford developed a revised ______________ of the atom.

a. Rutherford's model showed the atom as mostly ______________ space, with the ______________ in the middle.

Chapter **Outline** CONTINUED

b. Rutherford discovered the positively charged particle, the ________________________, which is found in an atom's nucleus.

c. Rutherford predicted the existence of another particle, with ________________________ electric charge, in the nucleus of atoms.

d. Rutherford's model did not accurately explain how ________________________ are arranged in the atom.

C. Bohr and the Hydrogen Atom

1. A Danish scientist, ________________________, studied the hydrogen atom and then proposed a new model for the arrangement of electrons in an atom.

a. A(n) ________________________ is a single wavelength of light that can be seen when the light from an excited element is passed through a prism.

b. A(n) ________________________ is a region in space corresponding to a certain energy through which an electron moves.

c. Bohr proposed that electrons moved in ________________________ around the nucleus.

d. Bohr thought that electrons fill the ________________________ energy levels of an atom

first, and start filling the next energy level away from the ________________________ after an inner level is full.

e. An element will react with other elements to try to receive a

full ________________________.

f. Bohr's model of circular orbits for electrons did not explain the behavior of electrons in

outer ________________________.

D. The Electron Cloud

1. Today, scientists think of an electron in an atom as being in a(n) ________________________, which is a region surrounding an atomic nucleus where an electron is

________________________ to be found.

Lesson 3: Elements, Isotopes, and Ions—How Atoms Differ

A. Different Elements—Different Numbers of Protons

1. A(n) ________________________ is a pure substance that can be identified by the number of protons in the nucleus of its atoms.

Chapter **Outline** CONTINUED

2. Each atom of a particular element has the same number of protons in its nucleus. This number is called the element's ________________________.

B. Atomic Number and the Periodic Table

1. In a chart called the ________________________, elements are arranged horizontally by increasing atomic number and vertically in rows of elements with similar chemical properties.
2. Elements in the periodic table are metals, nonmetals, and ________________________ .

C. Isotopes—Different Numbers of Neutrons

1. All atoms of an element have the same number of ________________________. Different atoms of the same element can have different numbers of ________________________.
2. The ________________________of an atom is the total number of neutrons and protons in the atom.
3. Atoms of the same element that contain different numbers of neutrons are called ________________________.
   - **a.** Some isotopes of certain elements are ________________________, meaning they spontaneously decay and release particles and/or energy.
   - **b.** Hydrogen has three isotopes, called protium, ________________________, and ________________________.
4. The ________________________ of an element is the weighted average of the mixture of an element's isotopes.

D. Ions—Gaining or Losing Electrons

1. A(n) ________________________ is an atom that no longer is neutral because it has gained or lost electrons.
   - **a.** If an element loses a(n) ________________________, it then has more protons than electrons and has a positive charge. An atom with a ________________________ charge is called a positive ion.
   - **b.** When an atom gains an electron, it forms an ion with a ________________________ charge because it has more electrons than protons. The resulting ion is called a ________________________.