Name _____ Date _____ Class _____

Introduction to Atoms

Guide for Reading

- What is the structure of an atom?
- How are elements described in terms of their atoms?
- Why are models useful for understanding atoms?

Scientists once thought that atoms were the of matter. Now, scientists know more. **Atoms are made of even smaller particles called protons, neutrons, and electrons.**

An atom is made up of a nucleus surrounded by one or more electrons. The **nucleus** is the very small center core of an atom. It is made up of smaller particles called protons and neutrons. **Protons** have a positive electric charge. **Neutrons** have no charge. **Electrons** move rapidly around the nucleus and have a negative electric charge.

In an atom, the number of protons equals the number of electrons. An atom is neutral because the positive and negative electric charges are balanced.

Electrons move around the nucleus in a sphere–shaped area. Scientists show this area as a cloud of negative charge. Electrons may be anywhere within the cloud. Electrons with lower energy usually move near the nucleus. Electrons with higher energy are usually farther from the nucleus.

Protons and neutrons are about equal in mass. Electrons are much smaller. It takes almost 2,000 electrons to equal the mass of one proton. Electrons, however, take up much more space in the atom than the nucleus. Atoms are so small their mass is measured in atomic mass units (amu). A proton or a neutron has a mass about equal to one amu.

Each element is made up of atoms that differ from the atoms of other elements. **An element can be identified by the number of protons in the nucleus of its atoms.** Every atom of an element has the same number of protons. Scientists have given each element a different **atomic number**, which is the number of protons in its nucleus.

Although all atoms of an element have the same number of protons, they may have different number of neutrons. **Isotopes** are atoms with the same number of protons and a different number of neutrons. An isotope is identified by its **mass number**, which is the sum of the protons and neutrons in the nucleus of that atom. Although isotopes have different mass numbers, they react the same way chemically.

Because atoms are so small, scientists create models to describe them. In science, a **model** may be a diagram, a mental picture, a mathematical statement, or an object that helps explain ideas about the natural world. These models are used to make and test predictions. Models of atoms are used to explain why elements react with other elements.

Name _____ Date _____ Class _____

Introduction to Atoms

Understanding Ideas

1. Name three particles found in an atom.

_____

2. Which two particles are found in an atom's nucleus?

_____

3. An atom has the same number of which two particles?

_____

4. How many protons are in a carbon atom?

_____

5. How are elements identified in terms of their atoms?

_____

_____

6. Explain why scientists use models to study atoms.

_____

_____

Building Vocabulary

Match each term with its definition by writing the letter of the correct definition on the line beside the term in the left column.

____ 7. nucleus	a. the sum of protons and neutrons in the nucleus of an atom
____ 8. proton	b. the very small center core of an atom
____ 9. neutron	c. an atom that differs in the number of neutrons, but has the same number of protons
____ 10. electron	d. the particle of an atom that moves rapidly around the nucleus
____ 11. atomic number	e. an object that helps expain ideas about the natural world
____ 12. isotope	f. the particle of an atom with a positive charge
____ 13. mass number	g. the number of protons in the nucleus of every atom of an element
____ 14. model	h. the particle of an atom that is neutral

Name _____ Date _____ Class _____

Organizing the Elements

Guide for Reading

- How did Mendeleev discover the pattern that led to the periodic table?
- What data about elements is found in the periodic table?
- How is the organization of the periodic table useful for predicting the properties of elements?

In 1869, the Russian scientist Dmitri Mendeleev discovered a set of patterns in the properties of the elements. **He noticed that a pattern of properties appeared when he arranged the elements in order of increasing atomic mass.** The **atomic mass** of an element is the average mass of all the isotopes of that element.

Mendeleev published the first periodic table. In the **periodic table**, the properties of the elements repeat in each period, or row, of the table. Mendeleev left three blank spaces in the table. He predicted that these spaces would be filled by elements that had not yet been discovered. He even predicted the properties of those elements. Those elements were soon discovered. Their properties are close to those predicted by Mendeleev.

The periodic table has been updated since Mendeleev's time as scientists discovered new elements. After protons were discovered, elements were rearranged according to atomic number. Some elements changed positions and the patterns of properties became more regular.

The modern periodic table contains over 100 squares, one for each element. **Each square includes the element's atomic number, chemical symbol, name, and atomic mass.** The **chemical symbol** for an element usually consists of one or two letters, such as Fe, the chemical symbol for iron.

The properties of an element can be predicted from its location in the periodic table. Each horizontal row of the table is called a **period**. As you move across a period from left to right, the properties of elements change in a predictable pattern. There are seven periods of elements.

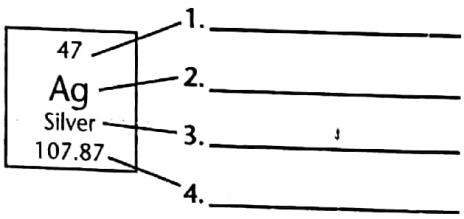
The elements in a column are called a **group**, or family. The groups are numbered from Group 1 on the left to Group 18 on the right. The family name of a group is typically the name of the first element in the column. Elements in each group have similar characteristics.

Name _____ Date _____ Class _____

Organizing the Elements

Understanding Main Ideas

The diagram below is a square from the periodic table. Label the four facts shown about each element.



Answer the following on a separate sheet of paper.

5. In what order did Mendeleev arrange the elements in the periodic table?
6. What do elements in the same column in the periodic table have in common?
7. What can you predict about an element from its position in the periodic table?

Building Vocabulary

From the list below, choose the term that best completes each sentence.

atomic mass
chemical symbol
periodic table
period
group

8. An element's _____ is its row in the periodic table.
9. Mendeleev was the first to arrange elements according to their properties in a(n) _____.
10. Elements in a(n) _____, or family, of the periodic table have similar characteristics.
11. A(n) _____ is an abbreviation for the name of an element and has either one or two letters.
12. The _____ of an element is the average mass of all the isotopes of that element.

Name _____ Date _____ Class _____

Metals

Guide for Reading

- What are the physical properties of metals?
- How does the reactivity of metals change across the periodic table?
- How are elements that follow uranium in the periodic table produced?

Most of the elements are metals, which are found in blue-tinted squares to the left of the zigzag line in the periodic table. Chemists classify an element as a **metal** based on physical properties. **The physical properties of metals include shininess, malleability, ductility, and conductivity.** A **malleable** material can be hammered or rolled into flat sheets and other shapes. A **ductile** material can be pulled out, or drawn, into a long wire. **Conductivity** is the ability of an object to transfer heat or electricity to another object. Many metals are good conductors. Several metals are also magnetic. They are attracted to magnets and can be made into magnets. Most metals are solids at room temperature.

The ease and speed with which an element combines with other elements and compounds is called its **reactivity**. Metals usually react by losing electrons to other atoms. Some metals react with oxygen in the air, forming metals oxides, or rust. This process is called **corrosion**.

The metals in a group, or family, have similar properties. Family properties change gradually as you move across the table. **The reactivity of metals tends to decrease as you move from left to right across the periodic table.**

The metals in Group 1 are the **alkali metals**. They are so reactive they are never found uncombined in nature.

Group 2 of the periodic table contains the **alkaline earth metals**. While not as reactive as the alkali metals, they are also so reactive that they cannot be found uncombined in nature.

The elements in Groups 3 through 12 are called **transition metals**. They form a bridge between the very reactive metals on the left and the less reactive metals and other elements on the right.

Groups 13 through 15 of the periodic table include metals, nonmetals, and metalloids. The metals in these groups are not nearly as reactive as those on the left side of the table.

The elements placed below the periodic table are called the lanthanides and actinides. Lanthanides are mixed with more common metals to make alloys. An **alloy** is a mixture of metals. Many of the actinides are synthetic elements. **Elements above uranium are made—or synthesized—when nuclear particles are forced to crash into one another.** Some synthetic elements are made in nuclear reactors. Powerful machines called **particle accelerators** make synthetic elements with atomic numbers above 95.

Name _____ Date _____ Class _____

Metals

Understanding Main Ideas

Answer the following on a separate sheet of paper. Use the periodic table in Appendix D.

1. What category of element is the most common in the periodic table? Where is that category found in the periodic table?
2. Sodium (Na) and calcium (Ca) are in different families of metals. Name the families of metals in which they belong, and describe each family's characteristics.
3. Would a metal in Group 13 be more or less reactive than a metal in Group 1? Explain.
4. In what periods are the lanthanides and actinides? Where are they placed in the periodic table? Why?

Building Vocabulary

Write the correct term on each line to complete the sentence.

conductivity
alloy
malleable
ductile
corrosion
particle accelerator
reactivity

5. The reaction of a metal with oxygen to form rust is called _____.
6. A material that is _____ can be hammered into sheets and other shapes.
7. A powerful machine called a(n) _____ moves nuclear particles fast enough to make larger nuclei when the particles collide.
8. The ability to transmit heat or electricity to other objects is called _____.
9. A material that is _____ can be drawn into a wire.
10. _____ is the ease and speed with which an element combines with other elements and compounds.
11. A(n) _____ is a mixture of a metal and at least one other element.

Name _____ Date _____ Class _____

Nonmetals and Metalloids

Guide for Reading

- What are the properties of nonmetals?
- How are metalloids useful?

Nonmetals are elements that lack most of the properties of metals. **Most nonmetals are poor conductors of electricity and heat and are reactive with other elements. Solid nonmetals are dull and brittle.** Nonmetals usually have lower densities than metals, and are poor conductors of heat and electricity.

Except for Group 18, most nonmetals readily form compounds with other elements. Many metals and nonmetals react with each other. Because atoms of nonmetals usually gain electrons, electrons move from metal atoms to nonmetal atoms. Nonmetals can also form compounds with other nonmetals by sharing electrons.

The elements in Group 14, the carbon family, can gain, lose, or share four electrons when reacting with other elements. Carbon is the only nonmetal element in the group. Carbon plays an important role in the chemistry of life.

Group 15 is also known as the nitrogen family. The two nonmetals in the group are nitrogen and phosphorus. These nonmetals usually gain or share three electrons when reacting with other elements. Nitrogen is an element that occurs in nature as a molecule formed from two nitrogen atoms bonded together. A molecule that is made up of two identical atoms is a **diatomic molecule**.

The elements in Group 16, the oxygen family, have three nonmetals—oxygen, sulfur, and selenium. These atoms typically gain or share two electrons in a reaction. The oxygen we breathe is O_2. Ozone is O_3.

The elements in Group 17 are known as the **halogens**. All but one of the halogens are nonmetals. A halogen atom typically gains or shares one electron when it reacts. In their elemental form, all of the halogens are very reactive.

The elements in Group 18, the **noble gases**, do not ordinarily form compounds. That is because the atoms of these elements do not gain, lose, or share electrons.

Hydrogen is the simplest element. Its atoms contain one proton and one electron. Because hydrogen's chemical properties are so different from the other elements, it cannot be grouped into a family.

On the border between the metals and the nonmetals are seven elements called metalloids. The **metalloids** have some of the characteristics of metals and some of the characteristics of nonmetals. **The most useful property of the metalloids is their varying ability to conduct electricity.** Some metalloids are used to make semiconductors. **Semiconductors** are substances that under some conditions can carry electricity, and under other conditions cannot carry electricity. Semiconductors are used to make computer chips, transistors, and lasers.

Name _____ Date _____ Class _____

Nonmetals and Metalloids

Understanding Main Ideas

Complete the following table. Use the periodic table in Appendix D.

Element	Metal, Metalloid, or Nonmetal	Family Name
Arsenic	1.	
Sulfur	2.	
Tin	3.	
Neon	4.	
Chlorine	5.	
Silicon	6.	

Answer the following questions on a separate sheet of paper.

7. Where in the periodic table are the nonmetals located? Where are the metalloids?
8. What element is not grouped with others in a family? What is its usual atomic structure?

Building Vocabulary

Match each term with its definition by writing the letter of the correct definition in the right column on the line beside the term in the left column.

____ 9. diatomic molecule
____ 10. halogen
____ 11. metalloid
____ 12. noble gases
____ 13. nonmetal
____ 14. semiconductor

a. a type of element that has some of the characteristics of metals and some of nonmetals
b. a family of unreactive elements whose atoms do not gain, lose, or share valence electrons
c. formed of two identical atoms
d. a substance that carries electricity under certain circumstances, but not under other circumstances
e. a type of element whose physical properties are generally opposite to that of metals
f. a family of very reactive elements whose atoms gain or share one electron