CHEMISTRY

Identifying Chemicals

4.01

Getting the Idea

Key Words.....
chemical
synthetic chemical
matter
element
synthetic element
mixture
compound

Everything around you is either energy or matter. Physical objects are examples of matter. These objects are matter because they have mass and volume. Energy is anything with the ability to do work or cause change. Examples of energy include light from the Sun or a lamp and sound. Unlike matter, energy has neither mass nor volume.

Chemical

A **chemical** is a substance used in or formed by a chemical process. A chemical may also be defined as any substance with a definite composition. In other words, a chemical is always made up of the same substances. For example, water is a chemical made up of one part oxygen and two parts hydrogen. Water is made of the same two substances in the same proportions whether it is in a pool, a puddle, the ocean, or the air.

Many chemicals exist naturally. Water, for example, is a naturally occurring chemical present in air, lakes, ponds, rivers, and the ocean. Other natural chemicals include carbon dioxide, gold, and the sugars that plants and animals use as food.

Some chemicals are not naturally occurring. They are made in laboratories by people. A chemical that is not formed in nature and is made by people is called a **synthetic chemical**. You make use of synthetic chemicals each day. For example, all plastics are synthetic chemicals. Metals such as steel and bronze also are synthetic chemicals.

Matter is anything that has mass and volume. Mass is the amount of matter in a substance. Volume is the amount of space the substance occupies. You can think of matter as the "stuff" that makes up something. Thus, all chemicals—naturally occurring and synthetic—are types of matter.

Did You Know

The fourth state of matter is plasma. Plasma is an ionized gas that can conduct electricity. Plasma forms when lightning strikes or when a neon light is turned on.

On Earth, most matter exists in three states, or phases—solid, liquid, or gas. This book and the chair you are sitting on are solids. A solid is matter that has a definite shape and volume. The air you are breathing is a gas. A gas has neither a definite shape nor a definite volume. Water and salad oil are examples of liquids. Liquids have a definite volume but not a definite shape.

Elements

The most basic kind of matter is an element. An **element** is a substance that cannot be broken down into simpler substances by ordinary chemical means. To change an element into another substance requires a tremendous amount of energy, such as the amount of energy that is released when a nuclear bomb explodes.

Scientists have discovered about 109 different elements. These elements are the building blocks of all matter. How can so many forms of matter be made from only 109 elements? Consider the alphabet. The 26 letters making up the alphabet can be combined and arranged in numerous ways to form all the words that make up the English language. In a similar way, the 109 known elements can combine in a great variety of ways to form all of the matter on Earth.

Naturally Occurring and Synthetic Elements

All of the known elements can be divided into two groups: naturally occurring elements and synthetic elements. Naturally occurring elements are elements that exist in nature, either on Earth or in other parts of the universe. Of the 109 known elements, there are 92 naturally occurring elements. As their name suggests, **synthetic elements** are elements that are made by scientists in a laboratory and do not exist in nature. Thus far, scientists have created 16 synthetic elements.

Naturally-Occurring and Synthetic Elements

Natural Elements	Synthetic Elements
Oxygen	Neptunium
Hydrogen	Plutonium
Copper	Americium
Lead	Curium
Gold	Berkelium

Mixtures and Compounds

Elements can combine in different ways to form mixtures or compounds. A **mixture** is a type of matter that forms when two or more substances are combined but do not join together chemically. Because they do not combine chemically, the parts of a mixture retain their individual identities, or properties.

You may have eaten a mixture for breakfast. Cereal is an example of a mixture because cereal is a blend of many different substances. Cereal may contain bran flakes, nuts, fruits, and milk. If you wanted to, you could separate these components from the cereal. Air is another example of a mixture. Air is a mixture of many gases, including oxygen, nitrogen, and carbon dioxide.

A **compound** is a type of matter that forms when two or more elements combine chemically. Unlike a mixture, the substances that join together to form a compound do not retain their individual properties. For example, table salt is a compound that forms when sodium and chlorine combine chemically. Sodium is a metal that explodes when combined with water. Chlorine is a poisonous gas. However, when these elements combine to form sodium chloride, they form the edible, white solid you know as table salt.

Natural and Synthetic Mixtures

Like elements, mixtures and compounds can be natural or synthetic. Minerals are examples of natural mixtures. A mineral called vanadanite is a mixture of the elements vanadium and lead. Stainless steel is an example of a synthetic mixture. Stainless steel is made by mixing iron with various other elements such as carbon, chromium, and nickel.

DISCUSSION QUESTION

Explain the difference between a compound and a mixture and give an example of each.

LESSON REVIEW

1. Which of the following is a definition of an element?

   A. An element is a natural substance that can be used to build matter.

   B. An element is a substance that cannot be easily changed into another substance.

   C. An element is a substance that can be found only in mixtures.

   D. An element is a substance that can be made only by humans.

2. What characteristic, or property, is shared by all forms of matter?

   A. color

   B. oxygen

   C. mass

   D. chemical make-up

3. Which of the following is a synthetic element?

   A. silver

   B. helium

   C. calcium

   D. europium

4. Which of the following represents a mixture?

   A. a piece of copper wire

   B. the oxygen gas in a pressurized tank

   C. a slice of mushroom pizza

   D. a lead fishing weight

Name _____ Period _____ Date _____

SECTION 1.1 | ATOMS ARE THE SMALLEST FORM OF ELEMENTS.

Reading Study Guide A

BIG IDEA A substance's atomic structure determines its physical and chemical properties.

KEY CONCEPT Atoms are the smallest form of elements.

Vocabulary

proton a positively charged particle within an atom
neutron an uncharged particle within an atom
nucleus protons and neutrons together at an atom's center
electron a negatively charged particle moving around the outside of the nucleus
atomic number the number of protons in the nucleus in an atom
atomic mass number combined number of protons and neutrons in a nucleus
isotope element that has the same number of protons, but a different number of neutrons from another atom of the same element
ion an atom that has gained or lost electrons

Review

If the statement is true, write *true*. If it is false, replace the underlined word to make it true.

1. Atoms are made of protons, neutrons, and <u>isotopes</u>. _____ .
2. Each element has a unique <u>atomic number</u>. _____ .

Take Notes

I. All matter is made of atoms. (p. 9)

3. About how many different elements make up everything on Earth?

_____

A–B. Types of Atoms, Names and Symbols of Elements (p. 10)

4. All living things contain some common elements. Their symbols are given below. Write the name of each element next to its symbol.

O _____ C _____ N _____ H _____

Which one of these is the most common element in the universe?

_____

II. Each element is made of a different atom (p. 11)

A–B. The Structure of an Atom, Atomic and Atomic Mass Numbers (pp. 11–12)

5. What are the three particles that make up an atom?

_____

6. What is the atomic number of an atom?

_____

7. Atomic mass number is the sum of _____ and _____.
What is an isotope?

_____

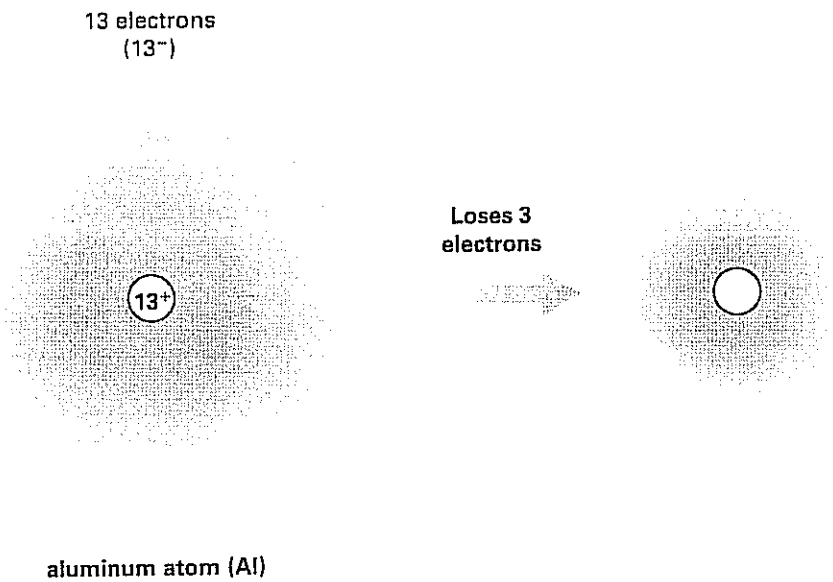
III. Atoms form ions. (p. 14)

8. An ion is an atom that has a positive or negative charge. What happens when an atom becomes an ion?

_____

A–B. Formation of Positive Ions and Formation of Negative Ions (pp. 14–15)

9. All aluminum atoms have 13 protons. Aluminum atoms often lose 3 electrons to form ions. Label the ion on the right side by noting the protons and electrons that remain.



Lesson 26

Properties of Matter

4.04

Getting the Idea

Key Words

property
physical property
chemical property
metal
nonmetal
metalloid
malleable
ductile
magnetism
conductor
insulator
semiconductor
density
solubility

Imagine you have a container of water and a container of motor oil. How can you decide which liquid is in each container? You can distinguish the liquids by looking at their properties. A **property** is any characteristic that can be used to identify and describe matter. Properties of matter are also helpful for deciding the uses of different materials.

Types of Properties

A **physical property** is a characteristic of a substance that can be observed without changing the identity of the substance. Mass, volume, color, hardness, and phase are physical properties of matter. Every substance has its own set of physical properties. As a result, a substance can be identified using its physical properties.

Matter also has chemical properties. A **chemical property** is a characteristic that describes how the matter will change under certain conditions. The ability to burn, rust, react to light, or react with acids are chemical properties of matter.

Metals, Metalloids, and Nonmetals

If you look at a periodic table, you will see a zigzag line between some elements on the right side. This line divides the elements on the periodic table into three groups: metals, metalloids, and nonmetals. Each group has specific properties that make it useful for different things.

Most elements on the periodic table are to the left of the zigzag line. These elements are metals. A **metal** is an element that is a good conductor of electricity and heat. In addition, most metals are solids at room temperature. An exception is mercury, which is a liquid.

Nonmetals are on the far right side of the periodic table. A **nonmetal** is an element that does not readily conduct electricity or heat. Most nonmetals are gases at room temperature. A few are brittle solids. Bromine is the only nonmetal that normally exists as a liquid.

Elements located along the zigzag line that separates metals from nonmetals are metalloids. A **metalloid** is an element that has some properties of a metal and some properties of a nonmetal.

Malleability and Ductility

Most metals are **malleable,** or able to be hammered and shaped or rolled into thin sheets. Gold and aluminum are examples of malleable metals. This property allows both metals to be rolled into very thin sheets known as foils. Gold foils are used as decoration. Aluminum foil is often used as a wrap for foods that are being cooked. Aluminum foil is used in this way because it is both malleable and able to conduct heat well.

Many metal elements are **ductile,** which means that they can be stretched or drawn into wires without breaking. Copper, aluminum, and gold are examples of ductile metals. These metals are often used in wires that carry electricity.

Magnetism

Magnetism is a force of attraction or repulsion that exists between like or unlike poles. The metals iron, cobalt, and nickel have strong magnetic properties. You may have magnets made of iron in your home that you use to hold papers or photos on your refrigerator door. Magnets can be used to generate electric current in wires. Electricity also can be used to make a piece of iron magnetic for brief periods of time. The relationship between magnetism and electricity makes magnets useful in many electronic devices such as speakers, doorbells, and home computers.

Electrical Conductivity

A **conductor** is a material or substance that allows electrons to flow through it easily. Most metals are good conductors of electricity. This property, combined with being ductile, makes metals useful as electrical wires. Most nonmetals do not allow electricity to flow through them easily. Materials that do not allow electricity to flow through them easily are called **insulators.**

Did You Know

Osmium is the densest element. Osmium is used to make the tips of ballpoint pens because it is extremely hard and resists wear.

Good Conductors and Insulators

Conductors	Insulators
Copper	Rubber
Silver	Wood
Aluminum	Plastic
Iron	Glass
Gold	Foam
Electrolyte solutions	Air

Recall that metalloids have some properties of both metals and nonmetals. Many metalloids are semiconductors. A **semiconductor** is a material that has conductive properties that lie between those of conductors and insulators. Germanium and silicon are examples of semiconductors. These elements can be made to carry electric current under certain conditions. Semiconductors are very useful in modern technology. Germanium, for example, is often used to make electronic devices. Computer chips are made from silicon.

Thermal Conductivity

Most metals are good conductors of heat. This property makes metals such as aluminum, copper, and cast iron useful in cooking pots and pans. Materials not made of metal tend to be poor conductors of heat. Rubber and plastic are mixtures of nonmetals. Because they do not conduct heat, these materials are useful in making the handles of pots and pans.

Density

Density is another property that is used in selecting a substance for a specific use. **Density** is defined as the ratio of mass to volume. The formula for density is shown below:

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

Density is usually expressed in grams per cubic centimeter, g/cm^3, or grams per milliliter, g/mL. For example, the density of water at 20°C is 0.998 g/mL. At a similar temperature, the density of crude oil can be more than 0.787 g/mL. Because the density of crude oil is less than that of water, crude oil floats on water. As a result, the oil that leaks from a damaged oil tanker floats at the surface of the water. This property allows much of the oil to be removed from the water by skimming it from the surface.

Test Tips . . .
Do not be concerned if the same letter appears consecutively as the answers. The correct answers to three consecutive questions may very well be C, C, C.

Solubility

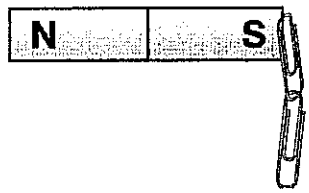
Solubility is another property that is used to select substances for a specific use. **Solubility** is a measure of how much of a substance dissolves in a given amount of another substance. For example, at a specific temperature, more carbon dioxide gas can dissolve in a given volume of water than oxygen gas can. This is one reason why carbon dioxide gas rather than oxygen gas is used to give some beverages their "fizz."

DISCUSSION QUESTION

Insulation is used in the walls of homes to prevent the flow of unwanted heat into or out of the home. Why would aluminum not be a good choice for insulating the walls of a house?

LESSON REVIEW

1. Examine the following illustration.



What property of matter is being illustrated in this drawing?

A. ability to conduct electricity

B. magnetism

C. malleability

D. ability to conduct heat

2. What two quantities must be known to calculate the density of a sample of matter?

A. color and mass

B. mass and volume

C. length and mass

D. solubility and mass

3. What does *malleable* mean?

   A. The substance can be pounded into a thin sheet.

   B. The substance can dissolve in water.

   C. The substance can conduct electricity.

   D. The substance has a high density.

4. A sample of lead has a mass of 33 grams and a volume of 3 cm^3. What is the density of lead?

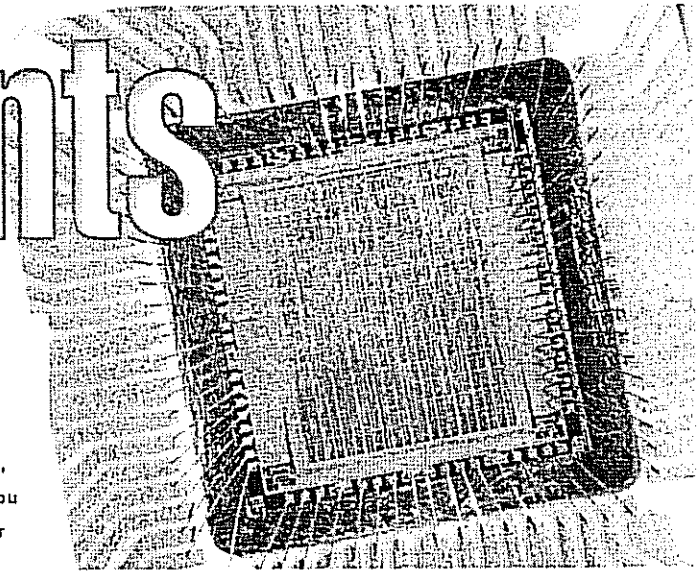
   A. 99 g/cm^3

   B. 33 g/cm^3

   C. 11 g/cm^3

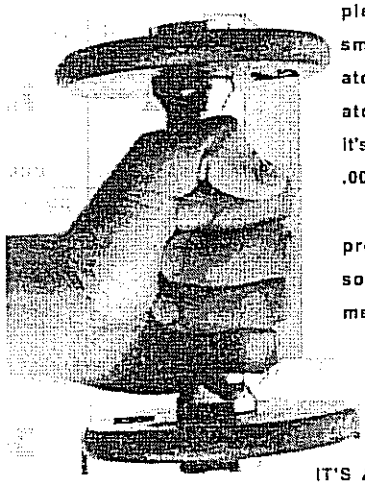
   D. 3 g/cm^3

Elements



Take a bit of rust off the bumper of an old car. With the right equipment—like a chemistry set—you can break that rust into two elements, iron and oxygen. Nothing to it.

But now let's say you try to break those grains of iron into something else. Not so easy. In fact, impossible. No matter what you do to that iron, no matter what equipment you have, it's going to stay iron. That's what makes it an element. All you can do with elements is divide them into smaller and smaller pieces of themselves until you get to the smallest piece: an atom. How small is an atom? Trying to understand the size of an atom will boggle your mind. (For the record, it's about .0000000045 of an inch—.0001 micron—across.)



There are 115 known elements, and probably at least three more will be discovered soon. Chemists arrange them into three groups: metals, nonmetals, and metalloids.

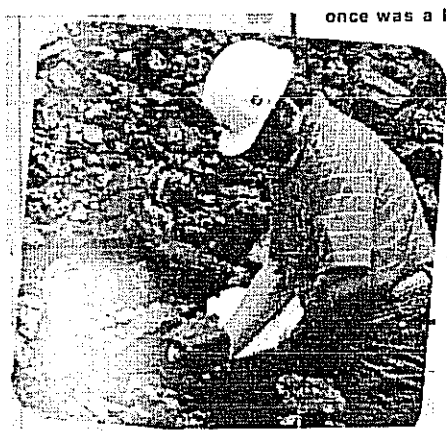
IT'S A HARD LIFE: METALS—Iron is an example of a metal—an especially strong one. As the major component of steel, it holds up tall buildings and provides transportation in cars, trains, and bikes. (Airplanes are mainly made of aluminum, which is lighter-weight.) In our blood, iron carries oxygen molecules to our cells. Like all metals, it has luster (shine), and conducts heat and electricity.

Like every metal except mercury, iron is a solid under normal conditions. (Mercury, the stuff in thermometers, will freeze, or turn solid, at -38.87° C, or -38° F. Make that a January day in North Dakota.)

BEWARE: METALLOIDS AHEAD—These elements can't seem to make up their minds about what they are. They act like both metals and nonmetals, so they've been lumped into a category called metalloids. And it's a category you'd better handle with care. One metalloid, arsenic, poisoned quite a few kings in the Middle Ages. Selenium in the soil can kill livestock. (But selenium is also found in your body and in computer chips, where it gets along perfectly well. So go figure.)

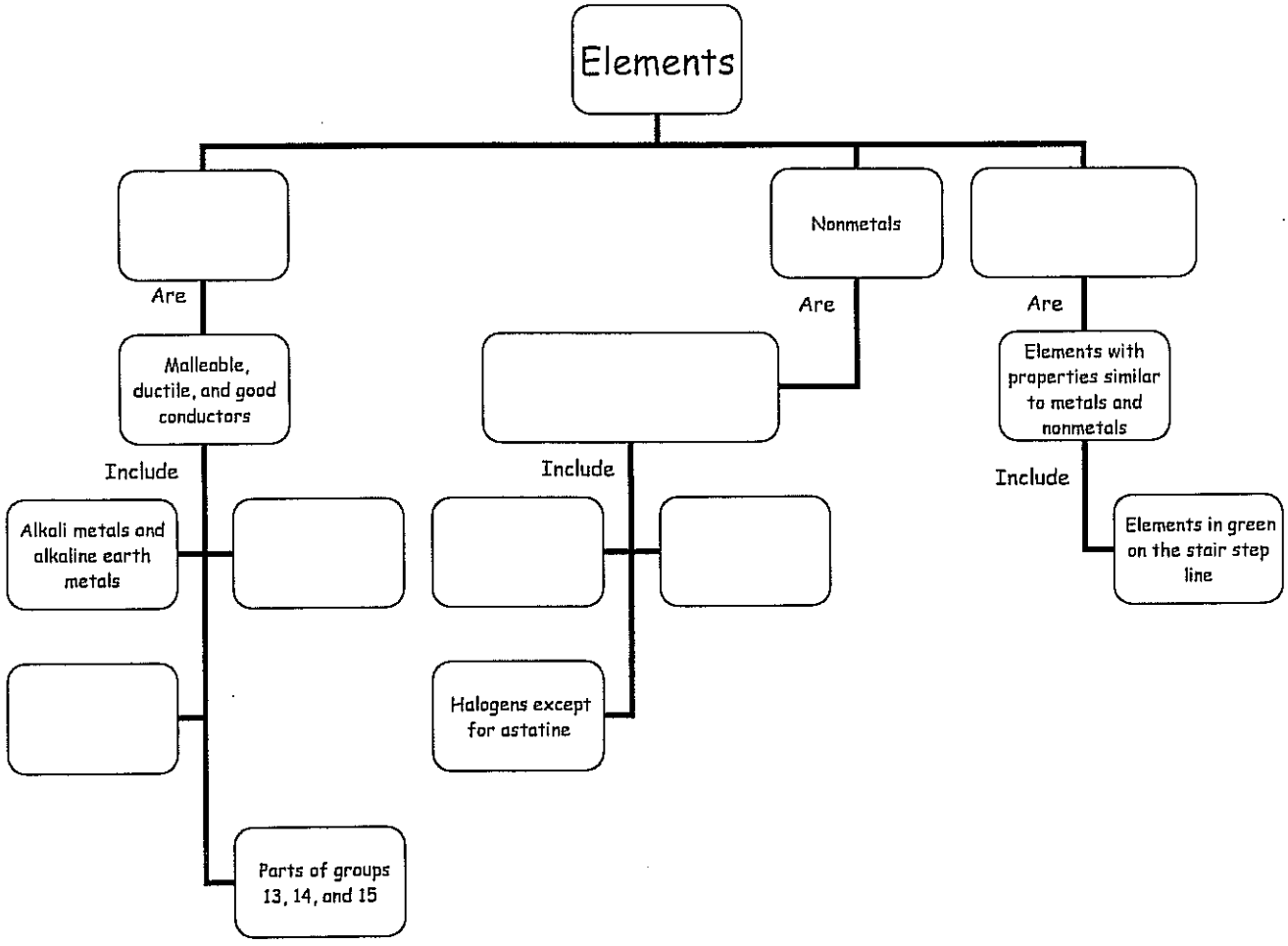
BABY, IT'S COAL OUTSIDE: NONMETALS—Metals might seem like the most useful group of elements, but life is mostly made of nonmetals. Take carbon, for example. About 18%, or one-sixth, of your body weight is carbon. And you're not alone. Every living thing contains this most elemental of the elements.

This lump of coal is basically a lump of carbon. It once was a living thing, some decayed plant life from a swamp. After heating up and sitting under tons of rock for 300 million years, all the hydrogen, oxygen, nitrogen, and other elements inside the plants were burned off, and the living thing became a lump of coal. Nonmetals are a big, varied category. They're found in nature as gases, liquids, and solids.



Properties of Matter

1. Use the following terms to complete: Transition elements, hydrogen, Metals, gas or brittle solid at room temp, Inner transition metals, metalloids, Noble gases.



2. Match the properties on the left to the type of elements that would most likely display them.

Column A	Column B
___ **14.** malleable	**a.** metalloids
___ **15.** dull or shiny	**b.** nonmetals
___ **16.** poor conductors	**c.** metals
___ **17.** tend to be brittle and unmalleable as solids	
___ **18.** always shiny	
___ **19.** also called semiconductors	
___ **20.** graphite in pencils	
___ **21.** always dull	
___ **22.** used in computer chips	
___ **23.** ductile	

End Section 1

LESSON 4

The Periodic Table

4.03

Getting the Idea

Key Words

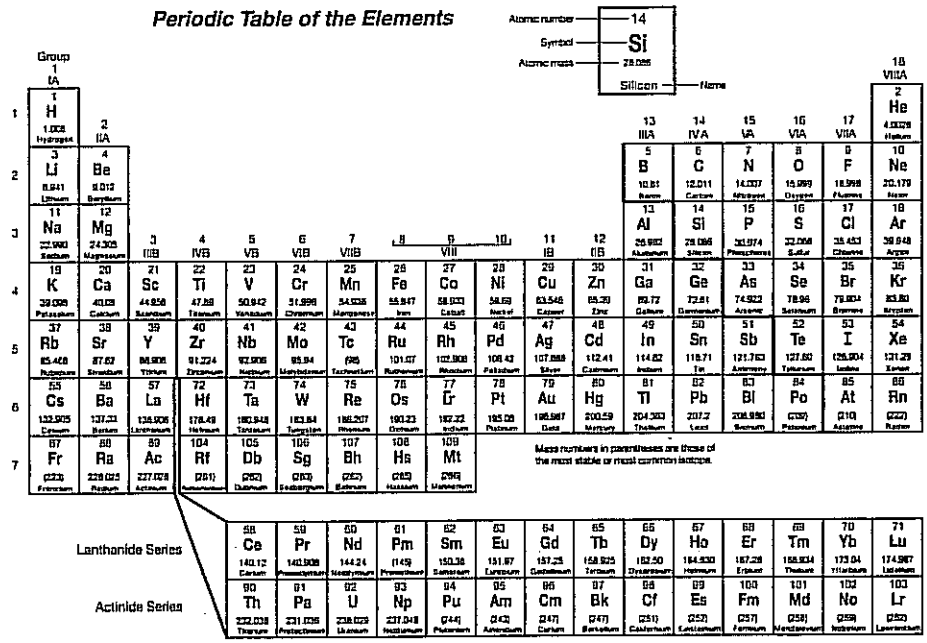
atomic mass
periodic table
atomic number
period
group
reactivity
metalloid
inert

Each kind of element is made up of many atoms of the same type. The properties of each element are determined by the structure of its atoms. About 60 elements had been discovered by 1860. A Russian teacher named Dmitri Mendeleev tried to find a way to organize information about these elements. Mendeleev wrote each element's name and properties on a separate card. He then tried to find a pattern in the properties of the elements that could be used to classify and keep information about them in an organized way.

The Periodic Table

The **atomic mass** of an element is equal to the number of protons and neutrons in the nucleus of one atom of the element. Mendeleev arranged the elements in order of their atomic masses. When he did this, he observed that elements with similar properties ended up in the same column. This arrangement of the elements was the first step in creating an incredibly useful scientific tool known as the periodic table.

The **periodic table** is a chart that organizes information about all of the known elements according to their properties. This chart, along with a key that explains the information contained in each box, is shown on the next page.



Periods and Groups

In his period table, Mendeleev arranged the elements in order of their atomic masses. Today's scientists arrange elements in order of their atomic numbers. The **atomic number** of an element is the number of protons contained in each nucleus of its atoms.

A horizontal row in the periodic table is called a **period**. Periods are numbered from 1 to 7. In the periodic table, elements in periods are arranged in order of increasing atomic number.

A vertical column on the periodic table is called a **group**, or chemical family. Elements in the same group have similar chemical properties. These similar properties occur because the elements that share a group all have the same number of valence electrons. On the periodic table, groups are numbered from 1 to 18 as well as from 1A to 8A.

Elements in groups 1–2 (IA–IIA) and 13–18 (IIIA–VIIIA) are the main group elements. Elements in Groups 3–12 are called transition elements. With the exception of hydrogen, the elements on the left side of the periodic table are metals. Elements on the right side of the periodic table are nonmetals. Some properties of metals and nonmetals are listed in the table below.

Test Tips . . .

Never select an answer based on the first thought that pops into your head. Carefully think about the question before answering.

Properties of Metals and Nonmetals

Properties of Metals	Properties of Nonmetals
Solid at room temperature, except mercury, which is a liquid	Most are gases, except bromine, which is a liquid
Malleable and ductile—can be shaped and drawn into wire	Are brittle in the solid phase
Have luster—are shiny	Have a tendency to be dull, not shiny and bright
Have high conductivity—are good conductors of electricity and heat	Are poor conductors of heat and electricity
Tend to lose electrons in chemical reactions	Tend to gain electrons in chemical reactions

The Chemical Families

Reactivity describes how likely an element is to form bonds with other elements. The most chemically active metals are in Group 1. All of these metals have one electron in their outermost energy level. The metals in Group 1 are called the alkali metals. The alkali metals easily combine with nonmetals. Although hydrogen (H) is the first element in Group 1, it is *not* an alkali metal. Hydrogen is placed in this group because, like the alkali metals, it has one valence electron. Despite this fact, hydrogen is a distinctive element with properties that do not closely resemble those of any other group.

The metals in Group 2 are called alkaline earth metals. Group 2 metals are highly reactive but are slightly less reactive and harder than Group 1 metals. The reactivity of both the Group 1 and Group 2 metals increases with increasing atomic number.

Groups 3 though 12 include the transition metals. Transition metals are generally hard solids with high melting points. A distinctive property of transition elements is that they often form colored ions.

Between the metals and nonmetals on the periodic table are elements called metalloids. **Metalloids** are elements that have some properties of both metals and nonmetals. The metalloids fall along the jagged line on the periodic table between the metals and nonmetals.

Halogens are nonmetals in Group 17. The halogens are the most reactive nonmetals. Reactivity in nonmetals increases as atomic

number decreases, so fluorine is the most reactive nonmetal. Halogens react with alkali metals to form salts. Elements in the halogen family exist in all three phases. Fluorine (Fl) and chlorine (Cl) are gases, bromine (Br) is a liquid, and iodine (I) and astatine (At) are solids at room temperature.

The last column of the periodic table is Group 18. The elements in Group 18 are known as the noble gases. Noble gases are the least reactive of all elements. At one time, noble gases were thought to be **inert**—unable to react chemically. However, in 1962 a compound containing xenon (Xe) and fluorine (Fl) was made. Many other compounds involving noble gases have since been made. In fact, all the noble gases except helium have been discovered to form compounds under extreme conditions.

DISCUSSION QUESTION

Why does the periodic table usually place hydrogen (H) apart from the rest of the elements?

LESSON REVIEW

1. Which of the following is the basis for arranging the elements in the periodic table?

   A. alphabetical order
   B. masses of atoms
   C. number of protons
   D. date of discovery

2. How many elements are listed in the periodic table?

   A. 60
   B. 72
   C. 93
   D. more than 100

3. What do elements in the same column have in common?

   A. similar chemical properties
   B. number of protons
   C. masses of their atoms
   D. size of their atoms

4. Which of the four elements in the table below is listed first on the periodic table?

Element	Atomic Number
Oxygen	8
Carbon	6
Gold	79
Calcium	40

A. oxygen

B. carbon

C. gold

D. calcium

Name _____ Period _____ Date _____

CHAPTER 1 Atomic Structure and the Periodic Table

SECTION 1.2 | ATOMS OF ELEMENTS MAKE UP THE PERIODIC TABLE.

Reading Study Guide A

BIG IDEA A substance's atomic structure determines its physical and chemical properties.

KEY CONCEPT Atoms of elements make up the periodic table.

Vocabulary

atomic mass average mass of all the element's isotopes

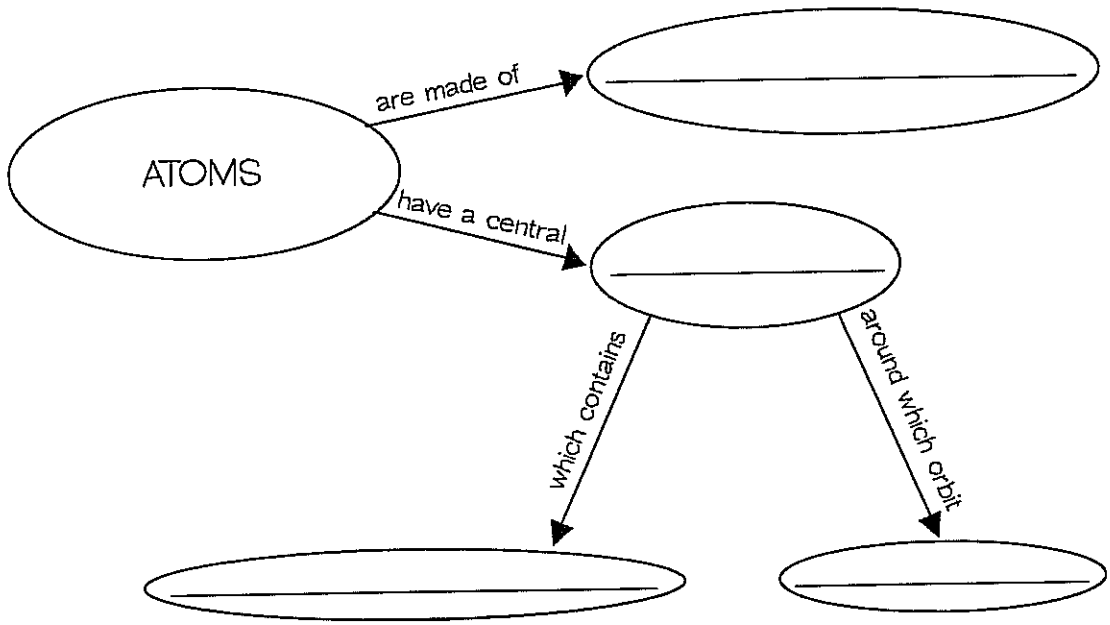
periodic table the table that shows the repeating pattern of properties of the elements

group the elements in a column of the periodic table

period a horizontal row in the periodic table

Review

1. Fill in the concept map for *atoms*.



Take Notes

I. Elements can be organized by similarities. (p. 17)

2. The average mass of all an element's isotopes is its _____.

A. Mendeleev's Periodic Table and Predicting New Elements (pp. 18–19)

3. Fill in the main-idea web for the main idea shown.

The elements in rows had similar _____.

Mendeleev produced the first periodic table.

A periodic table shows _____.

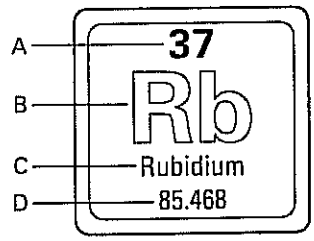
II. The periodic table organizes the atoms of the elements by properties and atomic number. (p. 19)

4. How is the modern periodic table organized?

_____

A. Reading the Periodic Table (p. 19)

5. One square from the periodic table is shown below. Label each of the parts of this element's square.



A _____

B _____

C _____

D _____

6. How many protons does the element shown above have?

_____

B. Groups and Periods (p. 22)

7. What are the vertical columns of the periodic table called?

_____

8. What is the horizontal row called?

_____

C. Trends in the Periodic Table (pp. 22–23)

9. How does atomic size change as you move down the periodic table?

_____

Name _____ Period _____ Date _____

SECTION 1.3 | THE PERIODIC TABLE IS A MAP OF THE ELEMENTS.

Reading Study Guide A

BIG IDEA A substance's atomic structure determines its physical and chemical properties.

KEY CONCEPT The periodic table is a map of the elements.

Vocabulary

reactive how likely an element is to undergo a chemical change
metals elements that conduct electricity, are shiny, and heat well
nonmetals elements with properties the opposite of metals
metalloids elements with properties between metals and nonmetals
radioactivity the process where atoms release particles and produce energy
half-life the amount of time it takes for half of the atoms in a set amount of a substance to decay

Review

1. Look at this column from the periodic table below. What properties are most likely similar among these elements? Explain why.

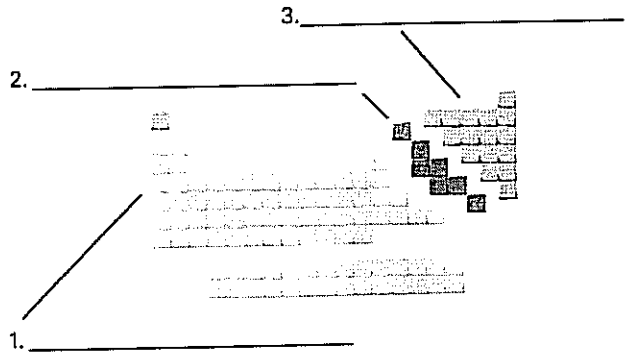
_____

_____

Take Notes

I. The periodic table has distinct regions. (p. 26)

2. The periodic table is divided into three regions—nonmetals, metals, and metalloids. Label these regions on the diagram below.



Name _____ Period _____ Date _____

Chapter Test A

Key Concepts

Choose the letter of the best answer. (4 points each)

____ **1.** The most common element in the universe is
- **a.** carbon
- **b.** hydrogen
- **c.** oxygen
- **d.** silicon

____ **2.** Atoms of an element always have a certain number of
- **a.** neutrons
- **b.** protons
- **c.** electrons
- **d.** ions

____ **3.** Isotopes of an element differ in the
- **a.** atomic number
- **b.** number of electrons
- **c.** ions the atom will form
- **d.** number of neutrons

____ **4.** When a calcium atom loses two electrons, it becomes
- **a.** a positive ion
- **b.** a different element
- **c.** radioactive
- **d.** a negative ion

____ **5.** The total number of protons and neutrons in the nucleus determines the atom's
- **a.** symbol
- **b.** atomic number
- **c.** atomic mass number
- **d.** size

Name _____ Period _____ Date _____

Select the letter of the term that best matches each description. (4 points each)

a. metal
b. nonmetal
c. metalloid
d. alkali metal
e. transition metal
f. noble gas
g. halogen

____ **6.** A chemist tests an element and finds that it does not react with any other element. What type of element is it most likely to be?

____ **7.** An element that has some properties of both metals and nonmetals is referred to as a(n)

____ **8.** A substance has a shiny surface. It is easy to shape by drawing it into a long thin wire. What is it?

____ **9.** These elements are often used to kill bacteria. They get their name from the Greek words for "salt formers."

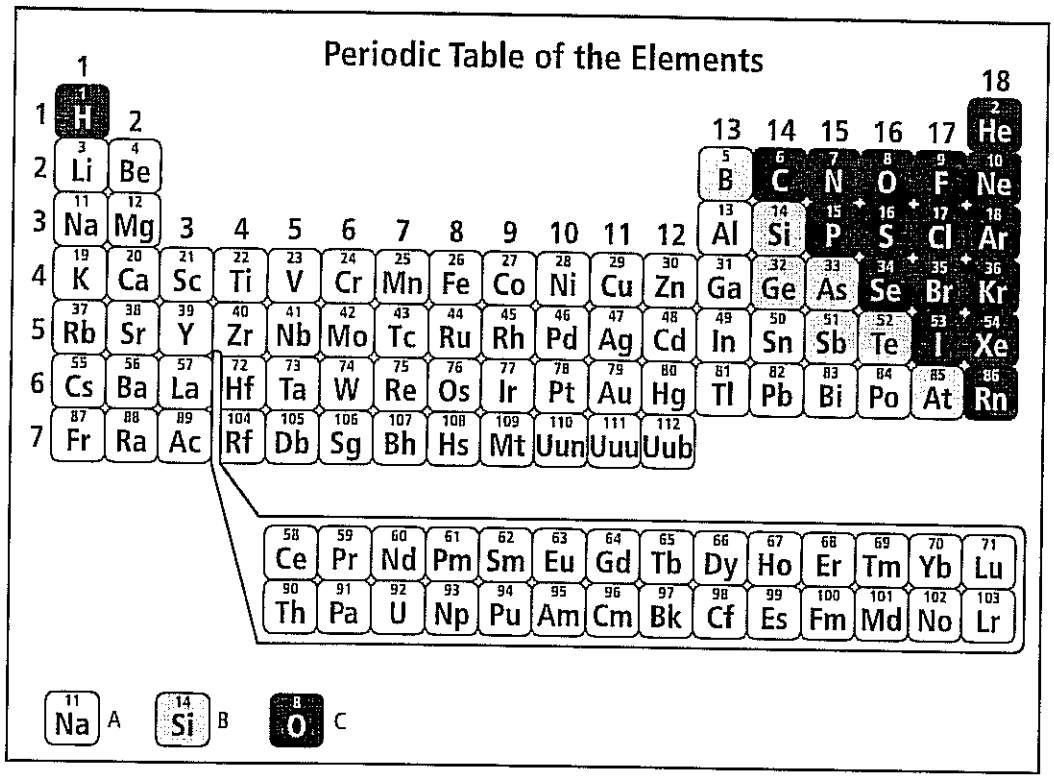
____ **10.** Gold is in the middle of the periodic table. What is it?

____ **11.** An element has a dull surface. It does not conduct electricity well. What is it?

____ **12.** This group is at the far left of the periodic table.

Interpreting Visuals

Using the diagram, answer the following questions. (6 points each)



13. What is one row of this diagram called?

_____

14. What is one column of this diagram called?

_____

15. Write the letter that corresponds to the color of the kind of element in the key.

Metals ____

Nonmetals ____

Metalloids ____

16. How does atomic number change as you move from left to right in the periodic table?

_____

17. Which are more reactive, the elements in Group 1 or the elements in Group 18?

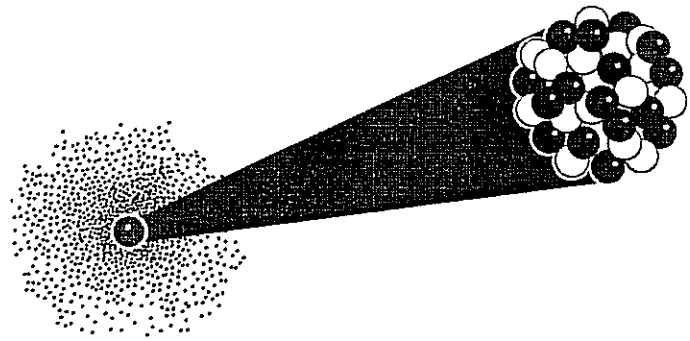
_____

Name Period Date

Constructed Response

Using the diagram, answer the following questions. (10 points)

Parts of an Atom



18. Label the parts of the atom on the figure. Then describe each part in the space below. Remember to include the terms *nucleus, protons, neutrons,* and *electron cloud.*

Extended Response

Answer the following questions on the back of this paper or on a separate sheet of paper. (6 points each)

19. Comparing and Contrasting Think about a neutral magnesium atom. Then think of a magnesium ion with a 2+ charge. How are these two alike? How are they different? Be sure to use the terms *proton, neutron,* and *electron* in your answer.

20. Predicting Tantalum and tungsten are located next to each other on the periodic table. Do you predict that scientists will discover an element that belongs between them? Why or why not? Use the terms *atomic number* and *proton* in your answer.

End Section 2

Lesson

Elements Form Compounds

4.02

Getting the Idea

Key Words.....
compound
molecule
chemical formula
atom
proton
neutron
electron
nucleus
valence electrons
ionic bond
ion
covalent bond

An element is a pure substance made of only one kind of atom that cannot be broken down into a simpler substance by ordinary chemical means. All matter is made up of elements. However, most matter exists as combinations of elements that have combined chemically.

Compounds

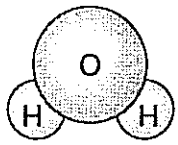
When two or more elements combine chemically, they form a new substance called a **compound**. Compounds have three important characteristics.

- Compounds have a definite composition.
- Compounds can be broken down into simpler substances by chemical means.
- Compounds can be identified by their physical properties.

Water is one of the most familiar examples of a compound. Water is made of up of two elements: hydrogen and oxygen. In water, two hydrogen atoms bond with one oxygen atom.

A **molecule** is the smallest unit of a compound that has all the properties of the compound. The make-up of a molecule is shown in a chemical formula. A **chemical formula** uses chemical symbols and subscripts to identify the number of atoms of each element in a molecule of a compound. The chemical formula for water is H_2O. H is the chemical symbol for hydrogen. O is the chemical symbol for oxygen. The 2 in the formula H_2O is a subscript. This subscript shows that a molecule of water has two hydrogen atoms. The O does not have a subscript. When no subscript is indicated, the number 1 is understood. So a molecule of water has two atoms of hydrogen and one of oxygen.

Test Tips . . .
Be sure to keep track of the time so that you do not find yourself without enough time to answer all the questions. Some of the questions that you do not answer may be among the easier ones on the test.



Water
H_2O

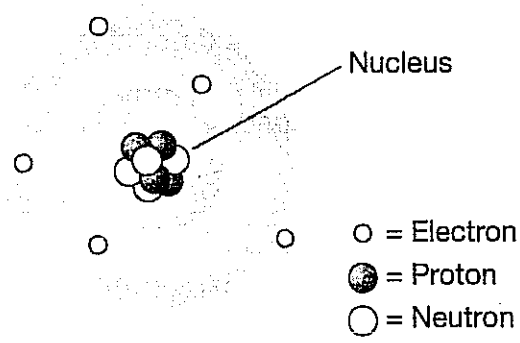
A water molecule has the formula H_2O. This formula tells you that the molecule has 2 hydrogen atoms and 1 oxygen atom.

Atoms: The Building Blocks of Compounds

An **atom** is the smallest unit of an element that has all the properties of the element. Atoms are the building blocks of matter. To understand how elements join together as compounds, you must understand the structure of an atom.

Atoms are made up of three types of particles: protons, neutrons, and electrons. A **proton** is a particle with a positive charge. A **neutron** is a neutral particle, meaning that it does not have a charge. An **electron** has a negative charge. As shown in the diagram, protons and neutrons make up the central core, or **nucleus**, of an atom.

Electrons orbit the nucleus in a region called the electron cloud. These electrons have different amounts of energy. Those nearest the nucleus have less energy than electrons farther from the nucleus. Electrons with similar amounts of energy are in the same energy level.



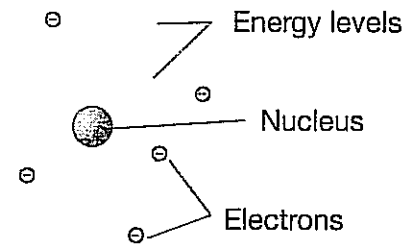
How Elements Form Compounds

Each energy level of an atom can hold only a specific number of electrons. The table shows the greatest number of electrons each of the first four energy levels of an atom can hold. The diagram shows how electrons are arranged in energy levels in a carbon atom.

Electron Configurations

Energy Level	Maximum Number of Electrons
1	2
2	8
3	18
4	32

Carbon Atom

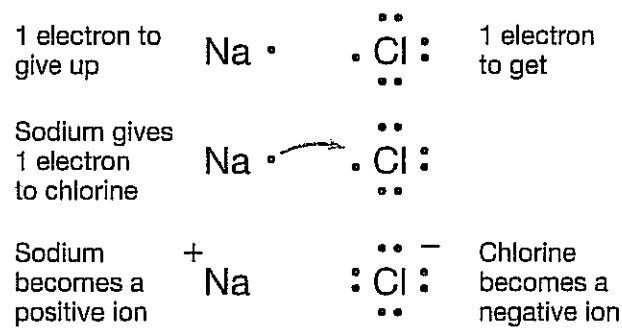


The electrons in the outermost energy level of an atom are called **valence electrons.** The number and arrangement of valence electrons determine how atoms combine with each other to form compounds.

Chemical Bonds

Chemical bonds are the forces that hold atoms together. Some bonds form when electrons from the outer energy level of one atom are transferred to the outer energy level of another atom. Bonds formed by the transfer of electrons are called **ionic bonds.**

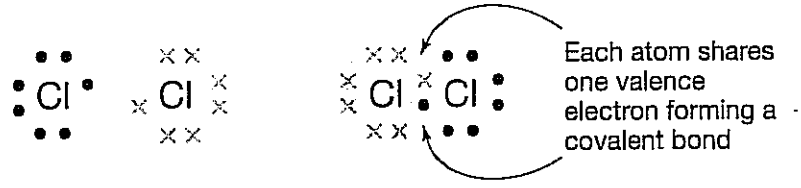
An **ion** is an atom that has gained or lost one or more electrons. An atom that loses electrons becomes a positive ion. An atom that gains electrons becomes a negative ion. Ionic bonds form because ions having opposite charges are attracted to one another. Sodium chloride (NaCl), or table salt, is a compound that forms from ionic bonding. The diagram shows how sodium (Na) and chlorine (Cl) form the oppositely charged ions needed to form an ionic bond.



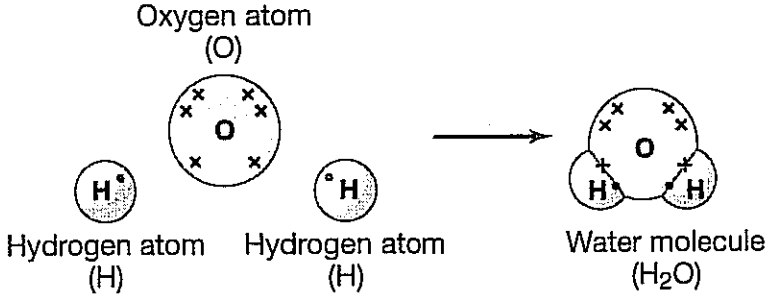
When forming bonds, atoms seek to have a total of eight electrons in their outer energy levels. To achieve this, atoms of elements that have one, two, or three valence electrons have a tendency to transfer their electrons to atoms of elements that have seven, six, or five valence electrons.

Some chemical bonds form when atoms share valence electrons. A **covalent bond** is formed when two atoms share electrons. As with ionic bonds, atoms forming covalent bonds seek to have a total of eight electrons in their outer energy levels. Covalent bonds are most likely to form between elements whose atoms have four, five, six, or seven valence electrons.

Atoms held together in covalent bonds form a molecule. A molecule can be made up of atoms of the same element or atoms of different elements. The diagram shows how a covalent bond forms between two atoms of chlorine (Cl), each with seven valence electrons.



A water molecule is an example of a compound made up of atoms of different elements. The diagram below shows how covalent bonds form between the atoms that make up a water molecule.



Same Elements, Many Compounds

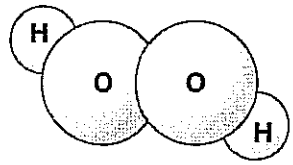
If you analyzed a drop of water from anywhere in the world, you would find that the ratio of hydrogen atoms to oxygen atoms is always 2:1. To form water, hydrogen and oxygen atoms can combine in only one way. However, water is not the only compound that can be formed by combining only hydrogen and oxygen atoms. Hydrogen and oxygen atoms can combine in different ways to form compounds other than water.

You probably are familiar with a substance known as hydrogen peroxide. Hydrogen peroxide is a liquid that is used for cleaning cuts and scratches to prevent infection. Like water, hydrogen peroxide is made up only of hydrogen and oxygen. However,

Did You Know

An English schoolteacher named John Dalton first proposed the atomic theory in 1808.

hydrogen peroxide forms when two hydrogen atoms bond with two oxygen atoms. This is shown in the formula for hydrogen peroxide, which is H_2O_2. In addition to having a different chemical formula, the properties of hydrogen peroxide are also very different from the properties of water.



Hydrogen peroxide
H_2O_2

Oxygen atoms often form covalent bonds with carbon atoms. Carbon dioxide is an example of a compound formed from oxygen and carbon. The formula for carbon dioxide is CO_2. Your body produces this gas as a waste product of respiration. When you exhale, you release CO_2 from your body into the air.

Another gas formed when carbon bonds with oxygen is carbon monoxide, which has the formula CO. Unlike CO_2, CO is poisonous and can cause serious damage or death if it is inhaled. As you can see, removing one oxygen atom from a CO_2 molecule can form a very different compound.

The Atomic Theory

Scientists noticed that there is only a limited number of ways that certain sets of elements can combine to form compounds. The key to how elements combine with each other is decided by the structure of their atoms, specifically the number of valence electrons. Observations of elements and how they interact led scientists to develop the atomic theory. The key ideas of the atomic theory are summarized in the table.

Atomic Theory

Key Idea	Explanation
All matter is composed of atoms.	Atoms are the building blocks of matter.
Atoms of a given element are identical.	All atoms of the same element have the same number of protons and electrons.
Atoms of different elements combine in simple whole-number ratios to form chemical compounds.	The ways atoms combine to form compounds is determined by the valence electrons of an element.

Compounds Are Found in Living and Nonliving Things

Elements combine in a multitude of ways to produce compounds that account for all living and nonliving substances. The types of compounds that make up living things include proteins, carbohydrates, fats, nucleic acids, and salts. Some common compounds in nonliving things include rubber, plastics, and medicines.

DISCUSSION QUESTION

Can a mixture be changed into a compound?

LESSON REVIEW

1. Which of the following compounds contains the greatest number of different elements?

   A. CO_2 **C.** $C_6H_{12}O_6$

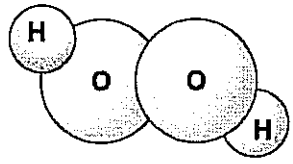
   B. $C_{22}H_{46}$ **D.** CH_4

2. Which of the following compounds contains the greatest number of atoms?

   A. CO_2 **C.** $C_6H_{12}O_6$

   B. $C_{22}H_{46}$ **D.** CH_4

3. A molecule made up only of hydrogen and oxygen atoms is shown.



   Which of the following shows the correct formula for this molecule?

   A. HO **C.** H_2O_2

   B. 2HO **D.** $H_2\,O_2$

4. The formula for a compound called nitrogen dioxide is written as NO_2. According to the atomic theory, what is a possible formula for another compound that forms from the elements N and O?

   A. NO_2 **C.** CO_2

   B. N_2O_4 **D.** NH_2

5. Which of the following is correctly arranged in going from simplest to most complex?

   A. compound → element → atom

   B. atom → element → compound

   C. atom → compound → element

   D. element → atom → compound

Chemistry Worksheet: Matter #1

1. A mixture **(is/is not)** a chemical combining of substances.

2. In a compound the **(atoms/molecules)** are **(chemically/physically)** combined so that the elements that make up the compound **(retain/lose)** their identities and **(do/do not)** take on a new set of properties.

3. The smallest identifiable unit of a compound is a(n) _____, which is made up of _____ which are chemically bonded.

4. True or False: A mixture is always made up of a combination of elements.

5. In a mixture, the substances **(lose/retain)** their identities.

6. In a mixture the substances involved **(can/cannot)** be separated by a simple physical process.
   In a compound the elements involved **(can/cannot)** be separated by a simple physical process because the elements are **(physically combined/chemically bonded)**.

7. True or False: An element can be broken down into a simpler substance.

8. The smallest identifiable unit of an element is a(n) _____.

9. From the following list of substances, circle the ones that are elements:

silver	carbon dioxide	wood alcohol	chromium
water	hydrogen	carbon	nitrogen
oxygen	gold	sugar	salt
air	sulfur	magnesium	nickel

10. Explain how to separate the sugar and water in a solution of sugar and water.

11. How would you separate a mixture of alcohol and water?

12. How would you separate sand and water?

13. Classify the following as pure substances or as mixtures:

air	gasoline	grain alcohol
water	sugar	gold
mercury	oxygen	salt water

14. Classify the following as heterogeneous or as homogeneous:

sand & salt mixture	hydrogen	iron
salt water	unfiltered air	iron with rust
pure water	an apple	nitric acid
tossed salad	granite	wood

15. Classify the following as an element, a compound, a solution, or a heterogeneous mixture:

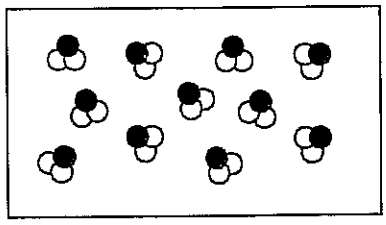
aluminum	raisin bread
carbon dioxide	water
sugar and water	sulfur
sulfuric acid	mercury
an orange	water & instant coffee
a pencil	carbon particles & sugar
nitrogen	air
gasoline	grain alcohol

Elements, Compounds, and Mixtures

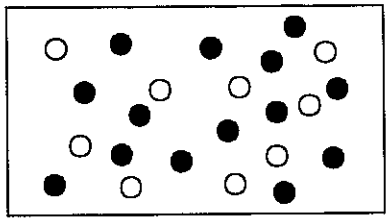
Classify each of the pictures below by placing the correct label in the blanks below:

A= Element
B= Compound
C= Mixture of elements
D= Mixture of compounds
E= Mixture of elements and compounds

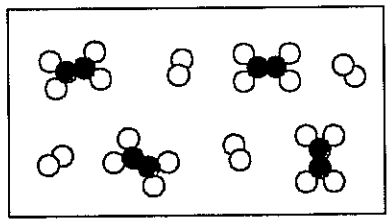
Each circle represents an atom and each different color represents a different kind of atom. If two atoms are touching then they are bonded together.



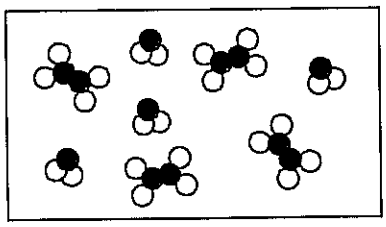
1) _____



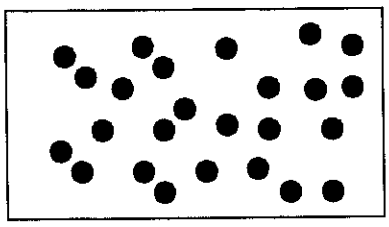
2) _____



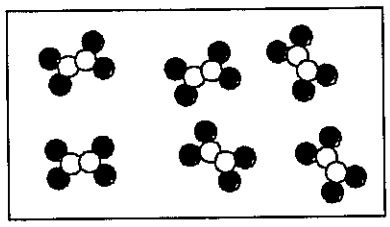
3) _____



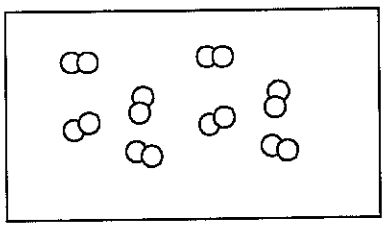
4) _____



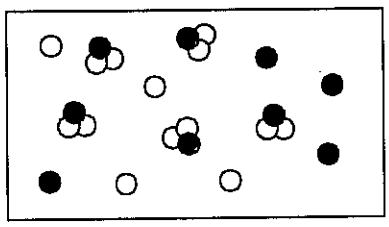
5) _____



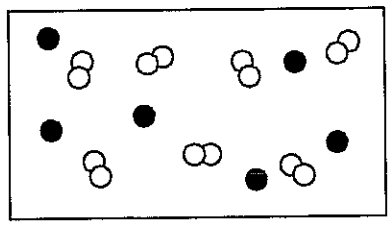
6) _____



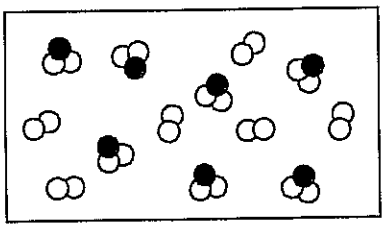
7) _____



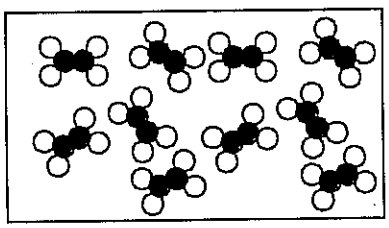
8) _____



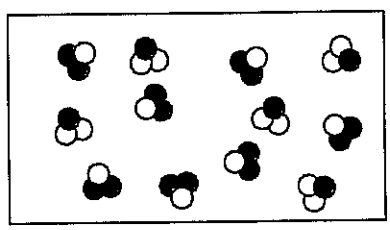
9) _____



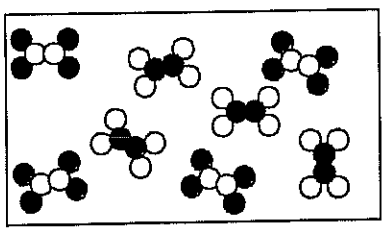
10) _____



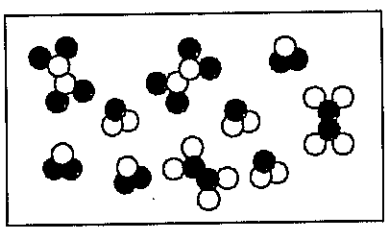
11) _____



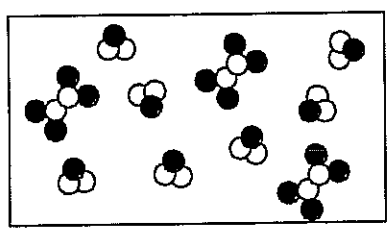
12) _____



13) _____



14) _____



15) _____

Identifying Substances

4.05

Getting the Idea

Key Words.....
physical property
density
melting point
boiling point
specific heat
solubility
solution
reactivity

A **physical property** is any characteristic of a substance that can be observed without changing the identity of the substance. Mass, volume, color, hardness, density, and phase are some of the physical properties of matter. You do not need to change the matter to observe or measure these properties. Every substance—element or compound—has its own set of unique physical properties. As a result, a substance can be identified using its physical properties.

Density

Density is a physical property of matter. **Density** is the mass per unit volume of a material. The formula for calculating density is

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

Common units of density are grams per cubic centimeter, g/cm^3, or grams per milliliter, g/mL.

The density of pure gold is 19.3 g/cm^3. However, if you were to calculate the density of a piece of 14-carat gold jewelry, you would find that its density is not 19.3 g/cm^3. The density of 14-carat gold jewelry is not the same as pure gold because 14-carat gold is not pure. Other metals are added to make 14-carat gold jewelry. Therefore, density is a property that can be used to identify a substance.

Melting Point and Boiling Point

Phase, or state, is a physical property of matter. On Earth, most matter exists in three phases: solid, liquid, and gas. Matter can change phase if it absorbs or releases energy. Most often, the energy absorbed or released is thermal energy, or heat.

The temperature at which a type of matter changes phase is consistent for each type of matter. Thus, these temperatures are physical properties that can be used to identify matter. **Melting point** is the temperature at which a solid changes to a liquid. The

Test Tips . . .
Some questions refer to information listed in a table. Be sure you know how to interpret this information.

melting point of water is 0°C. **Boiling point** is the temperature at which gas bubbles form in a liquid and rise to the surface to escape the liquid as a gas. The boiling point of water is 100°C.

Melting and boiling points can be used to identity substances. For example, if a colorless liquid boils at 78.4°C, you know that it is not water. If you refer to a table that lists the boiling points of different substances, you would find that ethanol boils at 78.4°C. Therefore, the colorless liquid might be ethanol. However, you cannot be sure the substance is ethanol until you test other properties of the liquid.

Specific Heat

The **specific heat** of a substance is the amount of heat needed to raise 1 gram (1 g) of a substance by 1 degree Celsius (1°C). The unit of specific heat is joules per gram per degree Celsius (J/g • °C). Specific heat values can be used to compare how different substances absorb heat. The table below lists the specific heat values of some common substances:

Specific Heat of Common Substances

Substance	Specific Heat (J/g • °C)
Water (liquid)	4.18
Ethanol	2.44
Water (solid)	2.06
Aluminum	0.897
Lead	0.129

Notice that lead has the lowest specific heat of the substances listed. In other words, if equal amounts of all of the substances in the table were heated, lead's temperature will rise fastest. Notice that the specific heat of ethanol is 2.06 J/g • °C. If you tested the colorless liquid discussed earlier and found its specific heat to be 2.06 J/g • °C, you may in fact have ethanol. If you found the liquid had a specific heat other than 2.06 J/g • °C, you could state that it was not ethanol.

Solubility

Solubility is another physical property that can be used to identify a substance. **Solubility** is a measure of how much of a substance dissolves in a given amount of another substance. Sugar is soluble (or able to dissolve) in water. When sugar dissolves in

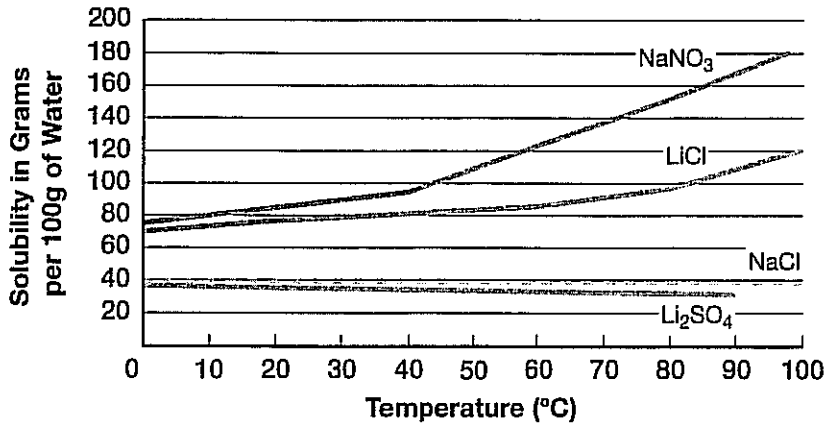
Did You Know

Not all solutions are made by dissolving a solid in a liquid. When oxygen dissolves in pond water, it forms a solution with the water. Brass is a solid solution made by mixing zinc and copper.

water, the two materials form a solution. A **solution** is a mixture in which the particles are too small to be distinguished from each other and remain constantly and uniformly mixed.

Potassium carbonate and potassium sulfate are white, powdery substances used in fertilizers. These compounds cannot be distinguished by looking at them. However, potassium carbonate is ten times more soluble in water than potassium sulfate. Therefore, you can identify a sample of each substance by measuring how much of each substance dissolves in a given volume of water.

The solubility of many substances changes with temperature. The change in solubility of substances at different temperatures is often plotted on solubility graphs. Many solubility graphs, like the one shown, indicate how the solubility of a substance in grams per 100 grams of water changes with temperature.



Other Properties Used to Identify Substances

Not all properties of substances are physical properties. Matter also has chemical properties. A **chemical property** is a characteristic that describes how the matter will change under certain conditions. One chemical property of matter is reactivity. **Reactivity** describes how likely an element is to form bonds with other elements. The reactivity of an element is determined by the number of valence electrons in its atoms.

DISCUSSION QUESTION

Can two different substances have the same physical property? Explain your answer.

LESSON REVIEW

1. Which of the following is an example of a solution?

   A. melting ice
   B. sand and water
   C. boiling water
   D. alcohol in water

2. The melting point of a substance is a physical property. What is melting point?

   A. the temperature at which the liquid turns to a solid
   B. the temperature at which the solid turns to a liquid
   C. the temperature at which the substance forms a gas
   D. the amount of heat the substance absorbs

3. Which of the following would be the same as a substance's melting point?

   A. boiling point
   B. specific heat
   C. freezing point
   D. solubility

4. Examine the following table.

Specific Heat of Common Substances

Substance	Specific Heat (J/g • °C)
Water (liquid)	4.18
Ethanol	2.44
Water (solid)	2.06
Aluminum	0.897
Lead	0.129

Which is a correct conclusion to make based on the information in the table?

A. More heat is needed to raise the temperature of 1 gram of liquid water 1°C compared to 1 gram of solid water.

B. Metals have a higher specific heat than water.

C. The specific heat of water does not depend on its phase.

D. It takes more heat to raise the temperature of 1 gram of lead by 1°C than it does for any other substance in the table.

Name_____

Solubility

1. Explain what is meant by solution. _____

   _____

   _____

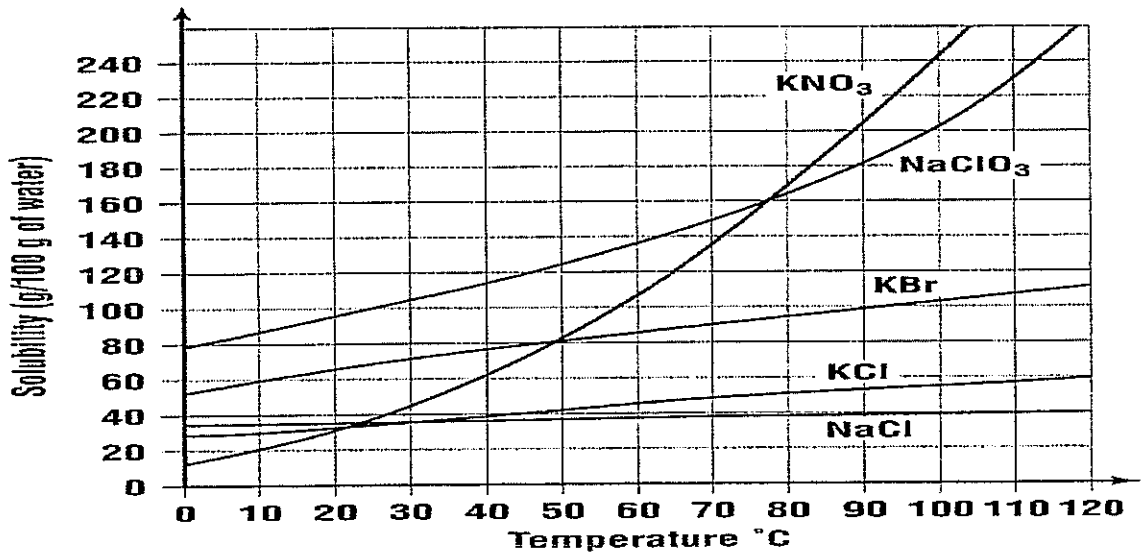
2. Name the three states of matter solutions can be and give an example of each.
   a) _____
   b) _____
   c) _____
3. Why is air considered a solution? _____

   _____

   _____
4. A solution is made of a _____ and a _____.
5. Using the answers from #4, which of the two would be found in a higher amount (concentration)? Which would be found in a lower amount?

   _____

Use the figure to answer questions 4-6



1. The solubility of which salt is least affected by temperature? _____
2. Which salt is more soluble in water, KCl or KBr? _____
3. At what temperature is the solubility of KBr the same as that of KNO_3?
4. How is concentrated different than dilute? _____

   _____

   _____

Name _____
Date _____

Unit 2: Multiple Choice Questions

1) Which of the following is an example of a chemical change?
   a) water boiling
   b) ice melting
   c) breaking glass
   d) paper burning

2) Which element is a metalloid?
   a) sodium
   b) arsenic
   c) neon
   d) cobalt

3) An example of a property of matter that can be observed without changing the identity of the matter is
   a) flammability
   b) reactivity
   c) solubility
   d) toxicity

Use your periodic table to locate the element in Group 18, Period 3. Answer questions 4 and 5 about this element.

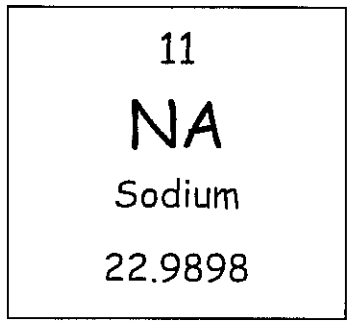
4) What is the state of matter for this element?
   a) solid
   b) liquid
   c) gas
   d) plasma

5) This element is a
   a) halogen
   b) noble gas
   c) alkali metal
   d) transition metal

6) Sodium and chlorine can react chemically to form table salt. How does the mass of the table salt formed in this reaction compare to the mass of the sodium and chlorine before the reaction takes place?
   a) The mass of the table salt formed is less than the sodium and chlorine.
   b) The mass of the table salt formed is greater than the sodium and chlorine.
   c) The mass of the table salt formed is twice the mass of the sodium and chlorine.
   d) The mass of the table salt formed is the same as the mass of the sodium and chlorine.

7) What does the law of conservation of mass mean during a chemical reaction?
   a) The total mass of the reactants is greater than the total mass of the products.
   b) The total mass of the reactants is the same as the total mass of the products.
   c) The total mass of the reactants is less than the total mass of the products.
   d) The total mass of the reactants and products cannot be measured.

Use the information in the following box from the periodic table to answer questions 8-9.



8) This element is classified as a
   a) Metal
   b) Nonmetal
   c) Metalloid
   d) Actinide

9) This element has ___ protons.
   a) 5
   b) 11
   c) 22
   d) 23

10) H_2O and H_2O_2 are compounds that are both formed by bonding hydrogen and oxygen. These compounds demonstrate
   a) that the second oxygen in hydrogen peroxide was accidently bonded.
   b) that elements bond in a multitude of ways to make compounds.
   c) that elements combine in random ways.
   d) that water has gained an extra oxygen in a secondary reaction.

11) Solid sodium is reacted with chlorine gas and a crystalline solid(sodium chloride) was formed.
   The crystalline solid is evidence that
   a) the sodium was broken down into tiny pieces by the chlorine.
   b) the reaction caused impurities to fall out.
   c) elements bond in a multitude of ways to make compounds.
   d) the chlorine solidified.

A substance has a mass of 25.6 g and a volume of 31.6 mL. Use the information in the chart below to answer questions 10-11.

Substance	Density (g/mL)
Mercury	13.6
Silver	10.5
Aluminum	2.7
Water	1.0
Ethanol	0.81

12) What is the identity of the substance?
   a) mercury
   b) aluminum
   c) water
   d) ethanol

13) If the substances were placed in water, which substance would float on the water?
   a) mercury
   b) silver
   c) aluminum
   d) ethanol

14) What characteristic property is shared by all matter?
   a) mass
   b) flammability
   c) corrosiveness
   d) toxicity

15) Which of the following statements is true about all natural elements?
   a) They are all metals.
   b) They all exist in nature.
   c) They can all be found in the soil.
   d) They are all made by humans.

16) Which of the following substances is synthetic?
   a) paper
   b) gold
   c) sodium
   d) uranium

17) When baking soda and vinegar are mixed, what evidence suggests a chemical change has occurred?
   a) the baking soda dissolves in the vinegar.
   b) the pH changes.
   c) evolution of a gas.
   d) light is given off.

18) A science teacher mixes calcium chloride and vinegar in a test tube. He passes the test tube around for his students to feel. The students notice that the test tube is hot. The science teacher asks the students to decide if the mixing of the two chemicals involved a physical or chemical change. He also asks the students to justify their answers. Which student gave the correct answer?
   a) Student 1: the change was physical because a temperature change occurred.
   b) Student 2: the change was chemical because a temperature change occurred.
   c) Student 3: the change was physical because the two chemicals mixed.
   d) Student 4: the change was chemical because the two chemicals mixed.

Terms Used in Part 5

Synthetic:

Compound: a pure substance that is created by 2 or more elements chemically reacting and joining together.

Mixture: The physical combination of 2 or more substances; can be separated by physical means.

Homogeneous mixture: A mixture that is evenly mixed; also called a solution.

Heterogeneous mixture: A mixture that is unevenly mixed.

Precipitate: an insoluble substance that is produced as result of a chemical reaction.

Endothermic reaction: A chemical reaction in which heat energy is absorbed.

Exothermic reaction: A chemical reaction in which heat energy is given off.

Law of Conservation of Mass: A law that states that matter cannot be created or destroyed during a chemical reaction. The mass of the reactants is equal to the mass of the reactants.

End Section 3

Lesson 5.0

Measuring Physical and Chemical Changes

4.06

Getting the Idea

Key Words.....
physical change
chemical change
chemical reaction
precipitate
reactant
product

Everything around you is matter. This matter can be changed in a variety of ways. For example, matter changes when a sheet of paper is ripped into smaller pieces. Matter also changes when the gases hydrogen and oxygen join together to form liquid water. The study of matter and the changes it undergoes are the focus of the branch of science known as chemistry.

Physical and Chemical Changes

Matter can undergo two types of changes: physical changes and chemical changes. A **physical change** alters the physical properties of a substance without changing the identity of the substance. Melting ice, tearing a sheet of paper, and sharpening a pencil are examples of physical changes.

Physical changes cause a change in properties such as volume, mass, and phase. In many cases, a physical change can be reversed and the matter can be returned to its former condition. For example, after an ice cube is melted into liquid water, the change can be reversed by cooling the water until it again turns to ice.

A **chemical change** occurs when a substance is changed into a new substance with different properties. During a chemical change, the identity of a substance is changed. All chemical changes involve chemical reactions. A **chemical reaction** is the process by which new substances are formed. Unlike a physical change, it is very difficult or impossible to reverse the effects of a chemical change.

Evidence of Chemical Reactions

Some substances do not undergo a chemical reaction when mixed together. Others do. How then can you know if a chemical reaction is occurring? There are several signs you can look for as evidence that a chemical reaction is taking place.

Did You Know

A small amount of energy must be supplied before propane and oxygen react. This energy can be supplied by a spark or by a match. However, the energy that is released when propane burns is much greater than the energy required to cause it to react with oxygen.

One sign of a chemical reaction is the formation of a precipitate. A **precipitate** is a solid that forms from a chemical reaction that takes place in a solution. Suppose you mix two colorless liquids in a test tube and a yellow solid forms. The yellow solid is a precipitate that tells you a chemical reaction has occurred and the identity of the original substances has changed. The table lists some other signs that a chemical reaction is taking place.

Signs of a Chemical Reaction

Sign	Explanation
Formation of a precipitate	A solid forms in a solution
Gas formation	Bubbles rising in a liquid or visible vapors escaping from a container are signs of a chemical reaction
Color change	A change in color of the substances involved indicates a chemical reaction
Energy change	A rise or fall in temperature, giving off light

Chemical Changes and Energy

During a chemical reaction, chemical bonds are either broken or formed. For example, bonds break when one substance is broken apart to form simpler substances. Bonds form when two or more substances join together to form a new substance. The breaking and forming of chemical bonds requires energy. Thus, a chemical reaction always involves a change in energy.

Energy is released whenever new bonds form to join substances together. For example, in a light stick, chemicals join together to form a new substance. The reaction that takes place releases energy as light. Most chemical reactions release energy as heat. This heat can be measured as an increase in temperature.

An example of a chemical reaction that releases heat occurs when you use a propane gas barbecue grill. Propane burns in the presence of oxygen. When propane gas joins with oxygen and burns, carbon dioxide and water are formed. The word equation written below shows this reaction:

$$\text{propane} + \text{oxygen} \rightarrow \text{carbon dioxide} + \text{water} + \text{energy (heat and light)}$$

In this equation, propane and oxygen are reactants. A **reactant** is a substance that takes part in a chemical reaction. Carbon dioxide and water are the products. A **product** is a substance formed

Test Tips . . .
Take your time if you have to transfer your answers from a worksheet to an answer sheet. Rushing may result in putting down the wrong answer even if you got it correct on your worksheet.

during a chemical reaction. When propane burns, heat and light energy are also released. This heat energy is used to cook food.

Some reactions require an input of energy before they occur. For example, water can be broken down into oxygen and hydrogen if electrical energy is supplied. The equations below summarize this chemical reaction.

$$\text{water} + \text{energy} \rightarrow \text{oxygen gas} + \text{hydrogen gas}$$

$$2H_2O + \text{energy} \rightarrow 2H_2 + O_2$$

When electricity is passed through water, you can observe that a chemical change has occurred because gases are produced. During this reaction, tiny oxygen and hydrogen gas bubbles rise to the surface of the water.

DISCUSSION QUESTION

A solid is added to water. The temperature of the water rises from 18°C to 22°C. What type of change does this indicate?

LESSON REVIEW

1. Which of the following is an example of a chemical change?

   A. water evaporating

   B. wood burning

   C. ice cream melting

   D. face blushing

2. Carbon combines with oxygen to form carbon dioxide. What is the word equation for this chemical reaction?

   A. carbon dioxide → carbon + oxygen

   B. carbon → carbon dioxide + oxygen

   C. carbon + oxygen → carbon dioxide

   D. carbon dioxide + oxygen → carbon

3. Which of the following may happen during a physical change?

   A. New substances are formed.

   B. Reactants form products.

   C. A precipitate is formed.

   D. The temperature may increase.

4. Examine the following chemical reaction.

   hydrochloric acid + sodium hydroxide → sodium chloride + water

   What are the reactants in the above reaction?

   A. sodium chloride and water

   B. sodium hydroxide and sodium chloride

   C. hydrochloric acid and sodium hydroxide

   D. hydrochloric acid and water

Conservation of Matter

4.07

Getting the Idea

Key Words.....
law of conservation of matter
molecule

A puddle of water disappearing and rust flaking off a metal fence are evidence that matter constantly changes in form as it undergoes physical and chemical changes. However, during such changes, no matter is created or destroyed. Thus, the total amount of matter remains constant. The observation that the total amount of matter does not change during a chemical reaction was first made by eighteenth century scientists.

The Law of Conservation of Matter

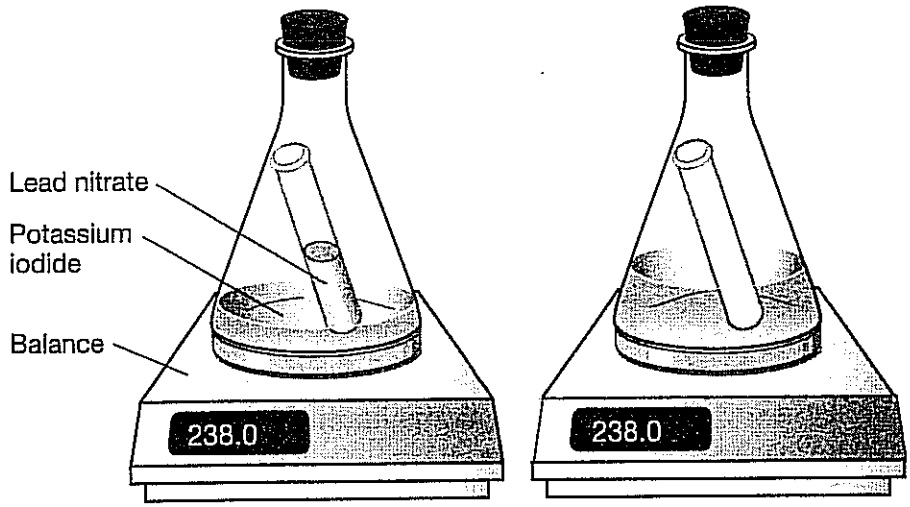
By measuring the masses of the reactants and products that take part in chemical reactions, scientists developed the law of conservation of matter. The **law of conservation of matter** states that during a chemical reaction, matter cannot be created or destroyed. Even though the matter may change from one form to another, the overall mass of the matter does not change. Thus, the mass of the products must equal the mass of the reactants.

An Example of Conservation of Matter

The experimental set-up shown illustrates the law of conservation of matter. In this experiment, a test tube containing lead nitrate is placed upright inside a flask that contains potassium iodide. The reactants cannot mix because the test tube is upright. A stopper is placed on the flask to form a closed system, or an environment in which matter and energy cannot enter or leave. The system is then placed on a balance so its mass can be measured.

Test Tips . . .

If a question includes a chemical equation, be sure you know how to identify the reactant and products.



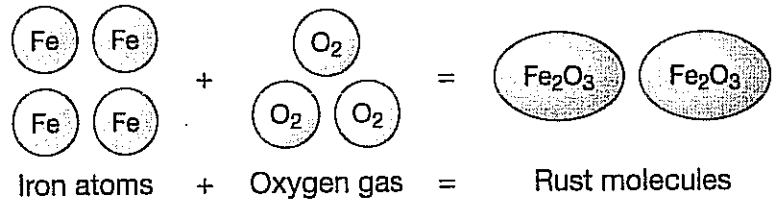
After the mass is measured, the entire system is turned upside down so the lead nitrate from the test tube can mix with the potassium iodide. A chemical reaction occurs that forms lead iodide and potassium nitrate. The second part of the illustration shows that although the matter in the system has changed in form (the reactants formed new products), the total mass of the system remains unchanged.

The Formation of Rust

Iron is a hard, solid, gray-colored metal. Rust is a flaky, reddish solid. When iron reacts chemically with oxygen gas in the air, they form rust, a compound known as iron oxide. The word equation for the formation of rust is written below:

iron + oxygen = iron oxide

Take a closer look at how iron oxide forms to understand how matter is conserved in this chemical reaction.



The reactants in this chemical reaction are four iron atoms and three molecules of oxygen gas (O_2). A **molecule** is the smallest unit of a compound. A molecule of oxygen is written as O_2. This indicates that each oxygen molecule is made up of two oxygen atoms. Because there are three oxygen molecules in the

Did You Know

Albert Einstein's famous equation, $E = mc^2$, states that although mass cannot be destroyed, it can be changed into energy. Similarly, energy can be changed into mass.

reactants, this means that there are six oxygen atoms in the reactants.

Now look at the product of this reaction—iron oxide. Notice that two molecules of iron oxide are formed. Each molecule of iron oxide has the formula Fe_2O_3. This formula indicates that each molecule of iron oxide contains two iron atoms and three oxygen atoms. Because there are two molecules of iron oxide, there are four iron atoms and six oxygen atoms in the product. The number of iron atoms and oxygen atoms in the product is the same number of atoms in the reactants.

All chemical reactions follow the law of conservation of matter. Look closely at the diagram showing how rust forms. Notice that the total number of iron atoms and oxygen atoms in the reactants is the same as that in the product. The atoms of the reactants were rearranged to form the atoms in the product, but no new atoms were added and no atoms were destroyed. Because no matter was made or destroyed, the total mass of the reactants equals the total mass of the product.

Determining the Mass of Reactants and Products

In a chemical reaction, the mass of the reactants always equals the mass of the products. Tin fluoride is sometimes added to toothpaste to prevent cavities. The following reaction shows how tin fluoride forms:

$$\text{tin} + \text{hydrogen fluoride} \rightarrow \text{tin fluoride} + \text{hydrogen}$$

If this reaction combines 118.7 grams of tin and 40.02 grams of hydrogen fluoride, the total mass of the reactants is 158.72 grams. Under ideal conditions, this reaction will produce 156.71 grams of tin fluoride and 2.01 grams of hydrogen. If you add the masses of the products, you will find that the mass of the products is 158.72 grams, which is the same as the mass of the reactants. Thus, the total mass of the reactants equals the total mass of the products and matter was not created or destroyed during the reaction.

Mass Conservation in Chemical Reaction

Mass of Reactants	Mass of Products
158.72 g	158.72 g

DISCUSSION QUESTION

How can a chemical reaction be compared to shuffling a deck of cards?

LESSON REVIEW

1. What does the law of conservation of matter state?

   A. The total mass of the reactants is greater than the total mass of the products.

   B. The total mass of the reactants is less than the total mass of the products.

   C. The total mass of the reactants equals the total mass of the products.

   D. Mass can be created or destroyed.

2. The reactants involved in a chemical reaction are shown.

   $$Na_2O + H_2O \rightarrow ?$$

   How many O atoms must be present in the product that forms from this reaction?

   A. 1

   B. 2

   C. 3

   D. 4

3. Hydrogen gas can be produced by the following equation:

   magnesium + hydrochloric acid → magnesium chloride + hydrogen

   If hydrogen atoms cannot be created, what is the source of the atoms in the hydrogen gas in this reaction?

   A. magnesium

   B. hydrochloric acid

   C. both magnesium and hydrochloric acid

   D. neither magnesium nor hydrochloric acid

4. During a chemical reaction, methane (CH_4) and oxygen (O_2) combine to produce carbon dioxide (CO_2) and water (H_2O). The balanced chemical equation identifies the reactants and products for this reaction along with some of their masses. What mass (in grams) of oxygen (O_2) is required for this reaction to occur?

CH_4	+	O_2	→	$2CO_2$	+	H_2O
16 g		?		44 g		36 g

A. 16

B. 36

C. 44

D. 64

Physical and Chemical Changes

Name: _____

Date: _____ Hour: ___

Place a check in the appropriate column:

Change	Physical Change	Chemical Change
Salt dissolves in water.		
Hydrochloric acid reacts with magnesium to produce hydrogen gas.		
A piece of copper is cut in half.		
A sugar cube is ground up.		
Water is heated and changed to steam.		
Iron rusts.		
Ethyl alcohol evaporates.		
Ice melts.		
Milk sours (goes bad).		
Sugar dissolves in water.		
Sodium and potassium react violently with water.		
Pancakes cook on a griddle.		
Grass grows on a lawn.		
A tire is inflated with air.		
Food is digested in the stomach.		
Water is absorbed by a paper towel.		
Ethyl alcohol boils at 79°C.		
Paper burns.		
Water freezes at 0°C.		
Fireworks explode.		
Alka-Seltzer gives off carbon dioxide when added to water.		
Clouds form in the sky.		

NAME _____

Chemistry I Worksheet
Classification of Matter and Changes

INSTRUCTIONS: Write **E** in the blank if the material is *heterogeneous* or **O** if it is *homogeneous.*

1. Wood _____
2. Freshly-brewed black coffee _____
3. Water _____
4. Lucky Charms® _____
5. Salt _____
6. Dirt _____
7. Sausage-and-mushroom pizza _____
8. Air _____
9. Milk _____
10. Gold _____

INSTRUCTIONS: Classify each of the following as an *element* [**E**], a *compound* [**C**], or a *mixture* [**M**].

11. Gold _____
12. Water _____
13. Seawater _____
14. Sugar _____
15. A chocolate sundae _____
16. Air _____
17. Carbon dioxide _____
18. Silver _____
19. Ice _____
20. A Big Mac® _____

INSTRUCTIONS: Classify each of the following properties of matter as *physical* [**P**] or *chemical* [**C**].

21. Color _____
22. Density _____
23. Burns easily (flammable) _____
24. Not affected by acids _____
25. Boils at 450 °C _____
26. Reacts violently with chlorine _____
27. Good conductor of heat _____
28. Dissolves readily in water _____
29. Melts at 145 °C _____
30. Malleable _____

INSTRUCTIONS: Classify each of the following changes in matter as *physical* [**P**] or *chemical* [**C**].

31. Grinding chalk into powder _____
32. Dissolving salt in water _____
33. Dissolving zinc in acid _____
34. Tearing a piece of paper _____
35. Stretching copper into wire _____
36. Burning gasoline _____
37. Hammering gold into foil _____
38. Melting ice _____
39. Digesting food _____
40. Making hydrogen from water _____

INSTRUCTIONS: Classify each of the following as an *intensive property* [**I**] or an *extensive property* [**E**].

41. Mass _____
42. Density _____
43. Melting point _____
46. Color _____
47. Volume _____
48. Length _____

Name _____ Period _____ Date _____

SECTION 3.2 | THE MASSES OF REACTANTS AND PRODUCTS ARE EQUAL.

Reading Study Guide A

BIG IDEA Chemical reactions form new substances by breaking and making chemical bonds.

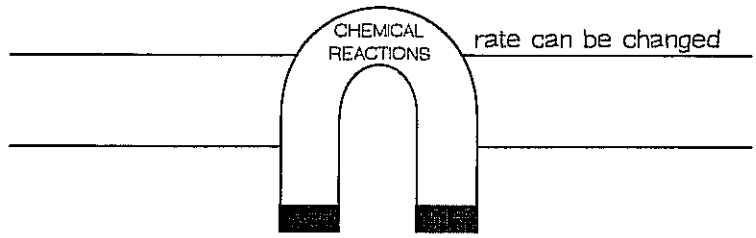
KEY CONCEPT The masses of reactants and products are equal.

Vocabulary

coefficient the number of molecules of a substance in a chemical reaction
law of conservation of mass atoms are not created or destroyed by a chemical reaction

Review

1. Fill in the word magnet for *chemical reactions*.



Take Notes

I. Careful observations led to the discovery of the conservation of mass. (p. 78–79)

2. _____ can never be created or destroyed in a chemical reaction.

   The mass of the reactants always equals the mass of the _____.

II. Chemical reactions can be described by chemical equations. (p. 80)

3. Use *reactants*, *product*, and *direction of reaction* to label the parts of the chemical equation below.

$$C + O_2 \rightarrow CO_2$$

_____ _____ _____

4. In the equation above, what is the number 2 called? What does it mean?

_____

III. Chemical equations must be balanced. (p. 81)

5. Is $H_2 + O_2 \rightarrow H_2O$ balanced? Count the number of atoms on each side to find out.

_____

Name Period Date

A–B. Balancing Chemical Equations and Using Coefficients to Balance Equations (pp. 81–82)

6. Balance the equation below by following the steps.

$H_2 + O_2 \rightarrow H_2O$

$H_2 + O_2$	H_2O
H =	H =
O =	O =

1. Count the atoms on both sides of the equation. Fill in the chart above.

2. How many oxygen atoms do you need to add to the right side to balance the number of oxygen atoms? _____

3. Add a coefficient to the right side in order to get your answer from step 2.

4. Count the atoms again. How many hydrogen atoms do you need to add to the left side of the equation to balance the hydrogen atoms all together?

_____.

5. What coefficient must be added to the hydrogen on the left side of the equation to balance the number of hydrogen atoms? _____

6. Count the atoms again. Is the equation balanced? _____

7. Write the balanced equation._____

7. Why can you change coefficients but not subscripts when balancing an equation?

_____

Name _____ Period _____ Date _____

CHAPTER 3 | CHEMICAL REACTIONS

Chapter Test B

Key Concepts

Choose the letter of the best answer. (4 points each)

____ **1.** The breakdown of water molecules (H_2O) into hydrogen (H_2) and oxygen (O_2) molecules is an example of a
- **a.** synthesis reaction
- **b.** combustion reaction
- **c.** chemical change
- **d.** physical change

____ **2.** The substances always present at the beginning of a chemical reaction are called
- **a.** catalysts
- **b.** precipitates
- **c.** products
- **d.** reactants

____ **3.** A reaction in which a reactant breaks down into simpler products is called a
- **a.** decomposition reaction
- **b.** synthesis reaction
- **c.** combustion reaction
- **d.** physical reaction

____ **4.** In a chemical reaction, the mass of the products is always
- **a.** less than the mass of the reactants
- **b.** equal to the mass of the reactants
- **c.** slightly more than the mass of the reactants
- **d.** twice as much as the mass of the reactants

____ **5.** To balance a chemical equation, you can change
- **a.** compounds
- **b.** subscripts
- **c.** coefficients
- **d.** elements

____ **6.** In the chemical equation $2H_2 + O_2 \rightarrow 2H_2O$, the arrow indicates
- **a.** the speed of the reaction
- **b.** the direction of the reaction
- **c.** the side of the reaction with more mass
- **d.** that a physical change has occurred

____ **7.** Which of the following best describes an endothermic reaction?
- **a.** absorbs energy and decreases temperature
- **b.** releases energy and decreases temperature
- **c.** absorbs energy and increases temperature
- **d.** releases energy and increases temperature

____ **8.** Bond energy is the energy needed to
- **a.** cause an endothermic reaction
- **b.** cause an exothermic reaction
- **c.** break chemical bonds in reactants and form chemical bonds in products
- **d.** break physical bonds in reactants and form physical bonds in products

____ **9.** The overall process of respiration is similar to a(n)
- **a.** elemental reaction
- **b.** synthesis reaction
- **c.** decomposition reaction
- **d.** combustion reaction

____ **10.** The use of photoresist is one step in the process of making
- **a.** sunlight
- **b.** enzymes
- **c.** silicon
- **d.** microchips

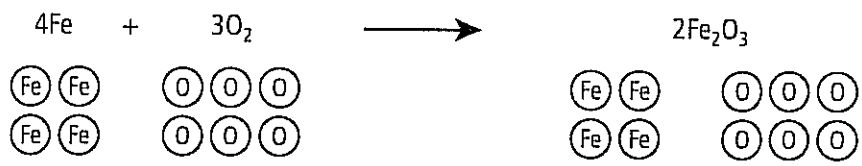
Name _____ Period _____ Date _____

Analyzing Data

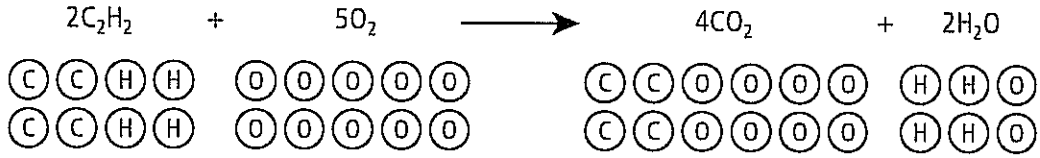
Using the equations, answer the following questions. (6 points each)

Chemical Equations

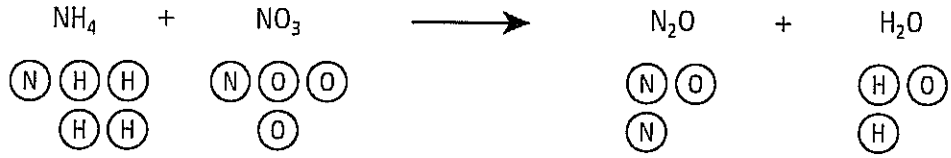
Equation 1



Equation 2



Equation 3



11. Which equation shows a synthesis reaction?

_____

12. List each reactant shown in equation 3.

_____

13. Write the formula of any product in equation 2.

_____

14. Which equation is not balanced?

_____

15. How could you balance this equation?

_____

End section 4

Lesson 33

Effects of Chemicals on Organisms

4.09

Getting the Idea

Key Words

dose
potency
toxicity test
exposure time
concentration

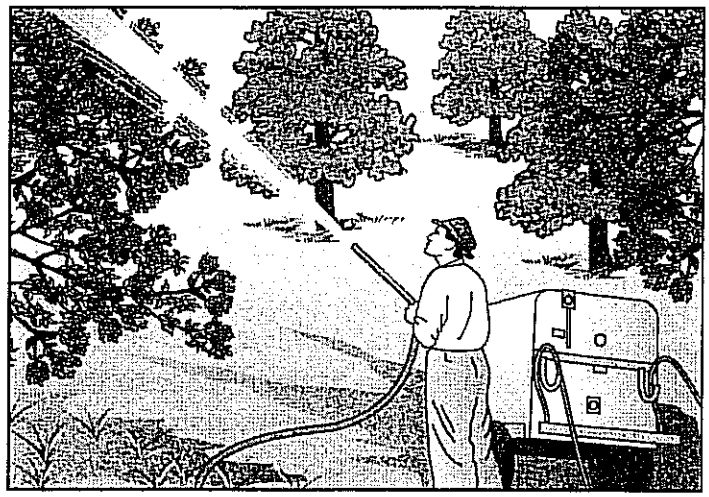
Many chemicals are used in industry, in agriculture, and in our homes. Many of these chemicals are helpful to people. Some, however, are harmful to humans and other organisms. Many chemicals used by humans can harm organisms and damage the environment. So, it is important to use chemicals carefully and dispose of them properly.

DDT and the Environment

Chemicals that are developed for a specific purpose can have unintended effects on the environment. It is often difficult to predict what effects a chemical may have on the environment. Often the effects of a chemical are not easily observed until they cause a serious problem. An example of such a chemical is the pesticide known as DDT.

DDT was first made in 1873. However, it was not until 1939 that a Swiss scientist named Paul Muller discovered that DDT could be used as a pesticide. DDT is very effective at killing the mosquitoes that spread malaria. Shortly after Muller's discovery, DDT spraying took place in many areas of the world. Its use saved the lives of many people living in areas where malaria is common.

DDT saved millions of human lives. However, its use was also harming the environment. In 1962, an American biologist named Rachel Carson published a book called *Silent Spring*. In her book, Carson described how DDT was harming bird populations in areas where it was used. Ten years after Carson made her claims, other scientists confirmed her data. This led to a ban of DDT use in the United States and several other countries.



Why did it take so long for people to recognize that DDT causes serious environmental problems? The answer rests with the fact that the effects of a chemical on organisms depend on several factors. These factors include the dose, potency, exposure time, individual susceptibility, and concentration.

Dose

The **dose** of a chemical substance is the amount that is given to one individual. When a doctor prescribes a medication, the dose is the amount of the drug a person should take. Sometimes the appropriate dose for a chemical is not well understood. In the case of DDT, the chemical was sprayed over wide areas, so it was impossible to know what dose of DDT any single organism had absorbed.

Potency

The **potency** of a chemical refers to how powerful it is. Any drug that produces a visible or measurable effect at a low dose is said to have a high potency. Scientists decide the potency of a drug by performing a **toxicity test**. For example, scientists may test a chemical to see how well it treats a certain disease and what the drug's side effects are. DDT's potency in the environment could not be determined because no one knew how much of the chemical any single organism was exposed to.

Exposure Time

The **exposure time** is how long an individual is exposed to a chemical. Determining the exposure time is not always simple because the stability of chemicals varies. Some chemicals break down quickly. When a chemical breaks down quickly, an organism is exposed to the chemical for only a short amount of time.

Did You Know

Concentrations can be measured in several ways, for example, the number of grams of a substance dissolved in a specific volume of water. However, concentrations can also be described in general terms, such as dilute and concentrated.

However, some chemicals such as DDT are very stable and remain in the environment for a long time. As a result, organisms continued to be exposed to DDT long after its use had stopped.

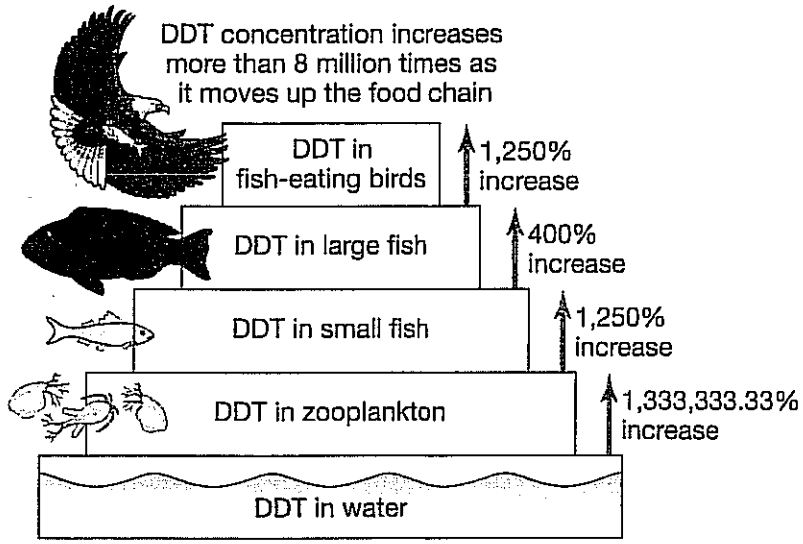
Individual Susceptibility

Individual organisms respond to a chemical in different ways. Individual susceptibility depends on the physical and genetic make-up of an organism. An individual who is overweight, eats fatty foods, and has a family history of heart disease is more susceptible to heart disease than a person who is at a healthy weight, eats healthy foods, and has no family history of heart disease.

Concentration

A chemical's **concentration** refers to the amount of a substance in a given volume. Therefore, concentration can be calculated by knowing the mass and volume of a substance. However, calculating the concentration of a chemical in the environment is not always easy. Many factors affect how far a chemical will spread. As a result, it is not possible to know the volume that the chemical occupies.

After DDT had been sprayed in the environment, it slowly seeped into ponds, streams, and other bodies of water. Small organisms took in the DDT but were not immediately affected because the chemical was not concentrated in their bodies. Fish ate these small organisms, and DDT became more concentrated in the fish. When the fish were eaten by birds such as ospreys, the DDT levels in the birds became even higher.



High levels of DDT in the ospreys did not affect the ospreys themselves. However, it did affect their offspring. The DDT caused the ospreys to lay eggs whose shells were very thin. The ospreys' eggs became so fragile and cracked so easily, that osprey young never had a chance to hatch. This led to a serious decline in osprey populations throughout the United States. Years after the use of DDT was banned in the United States, the osprey populations gradually began to recover.

DISCUSSION QUESTION

During the past 10 years, the osprey population has recovered. Explain why.

LESSON REVIEW

1. Which factor refers to the "strength" that a chemical substance has on an organism?

A. dose
C. toxicity
B. susceptibility
D. potency

2. Which factor refers to the amount of a chemical substance that is introduced into an organism?

A. concentration
C. dose
B. toxicity
D. potency

3. Which factor refers to how an organism responds to a particular chemical substance?

A. individual susceptibility
C. exposure time
B. death
D. low dosage

CHAPTER 4

EOG Review

1. Which of the following is true about a physical change in matter?

   A A physical change cannot be measured.

   B A physical change does not involve a change in energy.

   C A physical change does not involve the rearrangement of atoms.

   D A physical change occurs when a candle burns.

2. During a chemical reaction, methane (CH_4) and oxygen (O_2) combine to produce carbon dioxide (CO_2) and water (H_2O). The balanced chemical equation identifies the reactants and products for this reaction along with some of their masses.

CH_4	+	$2O_2$	→	CO_2	+	$2H_2O$
8 g		32 g		22 g		?

   What is the mass (in grams) of water formed by this reaction?

   A 8

   B 18

   C 22

   D 40

3. Which of the following statements refers to a physical property of a substance?

   A Carbon combines with oxygen to form carbon dioxide.

   B The density of copper is 8.93 g/cm^3.

   C Acids are corrosive.

   D Zinc metal reacts with an acid to produce hydrogen gas.

4. Where are the metalloids located in the periodic table?

   A on the left side

   B in the middle

   C toward the bottom

   D along a zigzag line toward the right side

5. Which of the following is a chemical substance that is not beneficial to humans?

   A antibiotic

   B pesticide

   C sugar

   D radon

6. Which of the following is a synthetic element?

   A mercury

   B hydrogen

   C plutonium

   D neon

7. What is the cause of FAS?

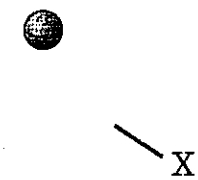
   A use of alcohol during pregnancy

   B too much cholesterol in food

   C an elevated level of calcium in the blood

   D overexposure to household cleaning products

8. What subatomic particle is found in the area of the atom marked X?



   A electron

   B proton

   C neutron

   D nucleus

9. What two values are needed to calculate the concentration of a chemical in an organism?

   A the dose and exposure time

   B the dose and the individual susceptibility

   C the amount and the volume occupied by the chemical substance

   D the density of the chemical substance

10. Which physical properties make metals suitable for use in electrical wiring?

   A malleability and ductility

   B conductivity and ductility

   C solubility and malleability

   D magnetism and ductility

11. What term is used to describe all the elements that are in the same vertical column on the periodic table?

   A atomic mass

   B atomic number

   C group

   D period

12. What is the product in the following reaction?

$$CaO + CO_2 \rightarrow CaCO_3$$

   A $CaCO_3$

   B CaO

   C CO_2

   D $CaO + CO_2$

13. If the reactants contain 12 carbon atoms and 4 oxygen atoms, what must be true of the products?

   A The products must contain a total of 16 atoms.

   B The products must contain 4 carbon atoms and 12 oxygen atoms.

   C The products must consist of carbon to oxygen atoms in a 1:1 ratio.

   D The products must contain 12 carbon atoms and 4 oxygen atoms.

14. Which statement applies to all natural elements?

   A They are all found on Earth.

   B They exist in nature.

   C They are made by humans.

   D They are all metals.

15. Which factor is ***least likely*** to play a role in an individual's susceptibility to a chemical substance?

A what the person eats

B the person's past history

C where the person lives

D the person's genetic make-up

16. What name is given to any chemical that is shown to cause cancer?

A oxidant

B contaminant

C carcinogen

D carbon-based

17. Which physical property requires use of a balance for its calculation?

A electrical conductivity

B malleability

C specific heat

D density

18. Examine the following table that lists various synthetic chemicals:

Name	Properties	Typical Uses
High density polyethylene	Stong, flexible, can be molded into shapes	Bottles, toys, playground equipment
Low density polyethylene	Flexible, soft, inexpensive	Plastic bags, tubing
Nylon	Can be drawn into a strong thread	Fabric, fishing line, rope, tire reinforcement fibers
Polycarbonate	Strong, transparent, hard	Windows, lenses, aircraft parts
Polypropylene	Hard, does not bend easily	Bottle caps, pens, durable packaging
Polystyrene	Lightweight, not very strong	Foam cups, insulation, packing material ("peanuts")
Polyvinyl chloride	Very strong, flexible	Garden hoses, tool grips
Teflon	Nonreactive, low friction	Coating for pans and utensils, medical implants, automotive seals and rings

What conclusion can you make based on the information in this table?

A Chemicals can pose a risk to human health.

B Chemicals can make life easier and more enjoyable.

C Synthetic chemicals have similar properties.

D Synthetic chemicals can be carcinogens.

Toxicology

1. Fill in the blank spots of the story using your TOXICOLOGY VOCABULARY.

   Angel was sick. So sick, in fact, that he could not even make jokes. He decided to go to the doctor. The doctor started by taking a thorough history. "Have you been _____ to any chemicals or possible allergens in the past week?" the doctor asked." Angel though for a moment and responded with "Just all of the sick kids at my middle school." The doctor snickered. Angel was still making jokes, but they were just really bad ones; he didn't realize that he was doing so. Next, the doctor examined Angel and came to the conclusion that he had come in contact with a known chemical contaminant in the area often found on fruit. It was a type of _____ that is designed to kill any insects that may be on the fruit. Over time, Angel accumulated a large amount of this chemical in his body, also known as a high _____. In addition, most of the fruit is covered in _____ to make it grow faster, which most likely just added to the problem. Normally this chemical does not have a large affect on humans, but due to _____ Angel was affected more than normal. On a good note, the doctor recommended a new medication on the market that actually converts the chemical into something less harmful that can be...excreted...easily. He prescribed Angel a very low _____ of the medicine as it only takes a very small amount to have a very large effect. In other words, it has a very high _____. Soon, Angel was back to his normal self and was, yet again, making classic jokes about video games, technology, Sir Mix-a-Lot, and being forever alone. The end.

2. What is the name given to chemicals that specifically are known to cause cancer?

3. Drinking alcohol during pregnancy can lead to abnormal growth and birth defects in the fetus due to a disease called _____.

Unit 7: Chemical Impact

Name _____
Date _____

Multiple-Choice Questions

1) What are the 3 ways you can be exposed to chemicals?
   a. ingestion, inhalation, and absorption
   b. ingestion, injection, and inhalation
   c. ingestion, sensation, and absorption
   d. ingestion, absorption, and visualization

2) Which of the following is the best definition for the term chemical?
   a. a substance that is added to a compound
   b. any substance that has come into contact with radioactivity
   c. any substance that has a defined molecular composition
   d. a substance that is composed of atoms

3) How can labels inform citizens of possible effects of exposure to harmful chemicals?
   a. the label shows warnings
   b. the label shows exact uses
   c. the label shows directions
   d. the label shows active ingredients

4) How does a food preservative work?
   a. A food preservative prevents a food from getting stale.
   b. A food preservative prevents the growth of harmful organisms.
   c. A food preservative slows down the chemical reactions in the food.
   d. A food preservative works in all the ways listed above.

5) Which of the following describes a chemical's capacity to produce the desired effect?
   a. dosage
   b. potency
   c. exposure
   d. susceptibility

6) How does chemical exposure affect an individual?
   a. All individuals are affected by chemical exposure in the same manner.
   b. Individuals are affected by chemical exposure in different ways.
   c. An individual's age, gender, and lifestyle can influences their response to chemical exposure.
   d. Both b and c

7) Which of the following can be caused by exposure to chemicals?
   a. birth defects
   b. cancer
   c. heart disease
   d. all of the above

8) What would be the **best** way you can reduce or eliminate the effects of chemical exposure?
   a. Keep harsh chemicals on a high shelf above your head.
   b. Use only toxic chemicals that are clearly labeled.
   c. Replace toxic chemicals in your home with something less harmful.
   d. Mix toxic chemicals with water before using them.

9) Which of the following shows chemicals used in a beneficial way?
   a. as medicines
   b. as insecticides
   c. as food preservatives
   d. all of the above

10) Which statement is true of pesticides?
   a. Pesticides are used to increase crop yield because they increase plant growth.
   b. Pesticides are safe if they are handled properly to avoid harm to people.
   c. Pesticides are safe since the government has allowed farmers to use them.
   d. Pesticides are used to increase the pests that live in the soil around the plants.

11) Which factor is most likely to affect a person's susceptibility in regards to a chemical substance?
   a. the person's genetic make-up
   b. the person's past history
   c. where the person lives
   d. what the person eats

Use the following table of various synthetic chemicals to answer question 12:

Name	Properties	Typical Uses
Nylon	Strong thread, stretchable	Ropes, hosiery, fabric
Scotch guard	Protective covering, clear	Upholstery covering
Poly urethane	Protective covering, clear	Wood product covering
Teflon	Little friction, clear/dark	Dishes, pots and pans covering, medical covering
Poly vinyl chloride	Flexible, strong	Yard hoses, tool handles

12) Study the chemicals. Which of the following statements is most reasonable?
   a. Synthetic chemicals are not beneficial to humans.
   b. Synthetic chemicals are beneficial to humans.
   c. Synthetic chemicals share the same properties.
   d. Synthetic chemicals share the same uses.

13) Which of the following determines why some people are affected by particular chemicals more than other people?
   a. dosage
   b. potency
   c. exposure
   d. susceptibility

14) Being exposed to chemical pollutants in the air would be more dangerous if a person suffers from _____ .
   a. asthma
   b. cancer
   c. diabetes
   d. food allergies

15) The dose-response relationship refers to
   a. the amount of one chemical in a larger amount of another chemical.
   b. the amount of a chemical that is taken into the body.
   c. the body's response to different amounts of a chemical.
   d. the body's response to the same amount of a chemical taken at different times.

Multiple Choice Answers:

1. a
2. c
3. a
4. d
5. b
6. d
7. d
8. c
9. d
10. b
11. a
12. b
13. d
14. a
15. c