Section 1

Metals

Essential Questions

- What are the properties of a typical metal?
- How do atoms bond in metallic bonding?
- Which elements are alkali metals and which are alkaline earth metals?
- What are of some common uses of the transition elements?

Review Vocabulary

group: vertical column in the periodic table

New Vocabulary

metal

malleable

ductile

metallic bonding

radioactive element

transition element

Properties of Metals

Coins, paper clips, and some baseball bats are made of metals. **Metals** are elements that are shiny, malleable, ductile, and good conductors of heat and electricity. Except for mercury, metals are solids at room temperature. The shiny property of metals is called metallic luster. Metals are **malleable** (MA lee uh bul), which means they can be hammered or rolled into sheets. Metals are also **ductile**, which means they can be drawn into wires. The figure below shows the malleability and ductility of metals.

Metals are malleable: they can be hammered into thin sheets.

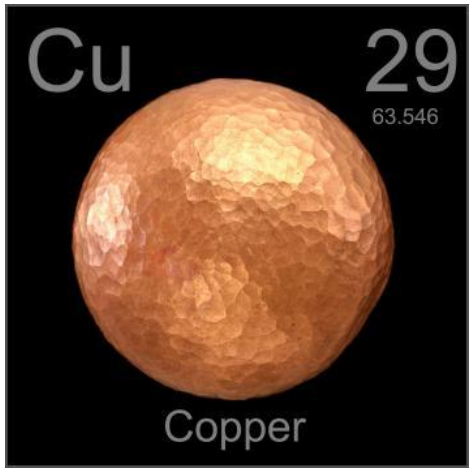
Metals are ductile: they can be drawn into wires.

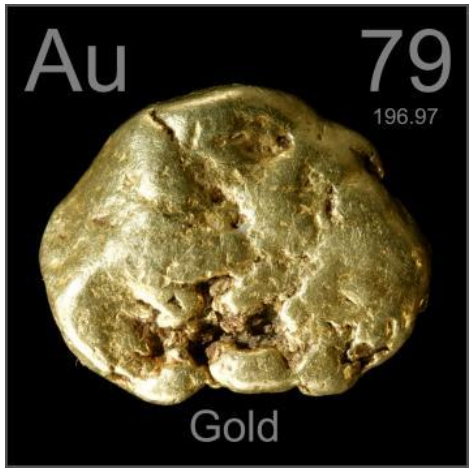
(l)Juan Silva/Getty Images, (r)Photodisc/Getty Images

PROPERTIES OF METALS

Physical Properties:

- Solid at room temperature
  - exception: Hg
- Silvery-gray
  - exception: Au and Cu
- Good Conductors
- Metallic luster (shine)
- Malleable
- Ductile



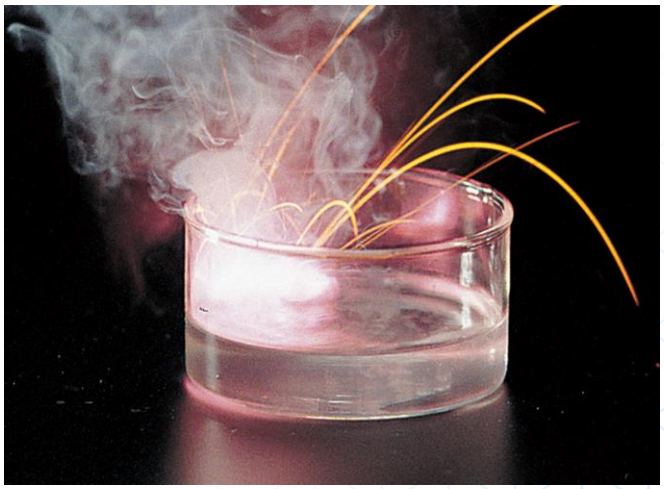


Chemical Properties:

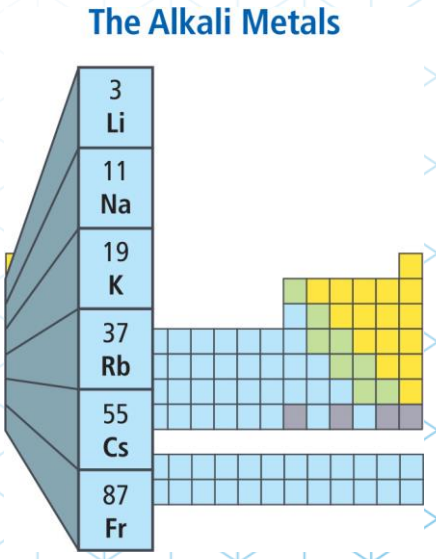
- Lose Electrons (makes positive ion)
- Corrode easily

The Alkali Metals

The elements in group 1 of the periodic table are the alkali (AL kuh li) metals. Like other metals, alkali metals are shiny, malleable, ductile, and good conductors of heat and electricity. However, they are softer than most other metals and are the most reactive metals. They react rapidly and sometimes violently with oxygen and water, as shown at the right. Because they are so reactive, alkali metals do not occur naturally in their elemental forms, and pure samples must be stored in oil to prevent reaction with oxygen and water in the air.

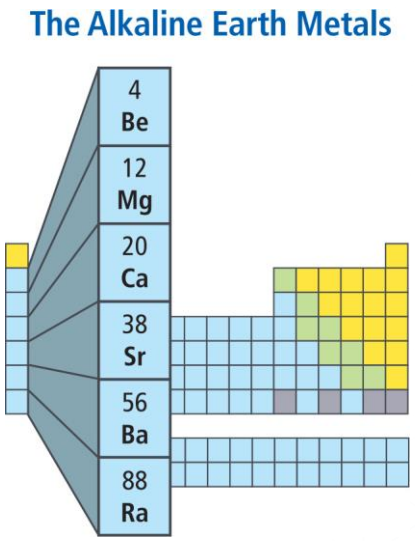


Stephen Frisch/McGraw-Hill Education



The Alkaline Earth Metals

The alkaline earth metals make up group 2 of the periodic table. Like most metals, these metals are shiny, malleable, and ductile. Like the alkali metals, they combine readily with other elements and are not found as free elements in nature.



Michael Parrish Photography/Getty Images

The Transition Elements

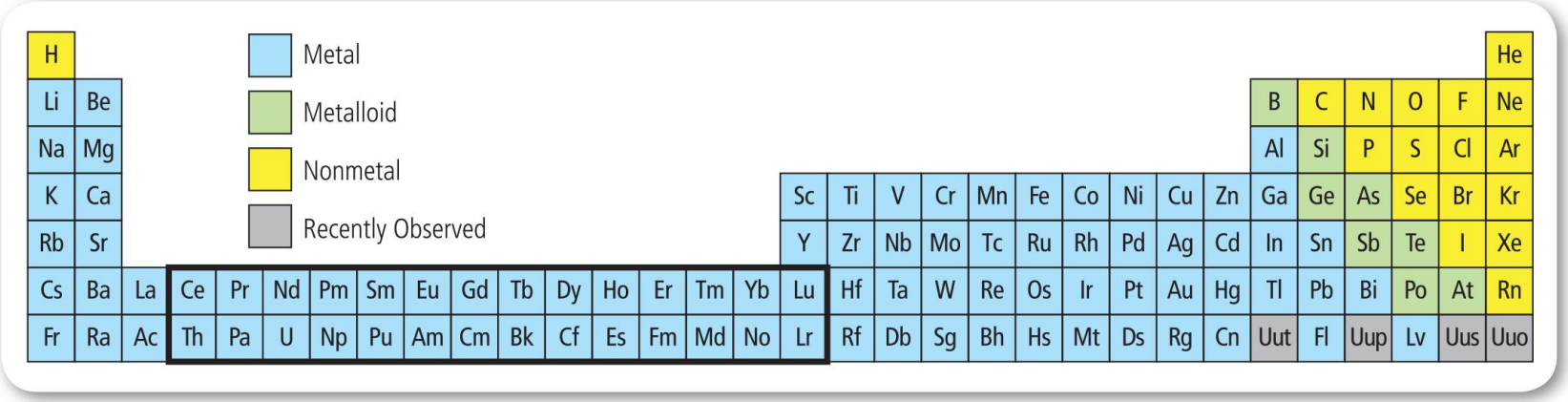
Many transition elements, such as iron and gold, are familiar because they are less reactive than the metals in groups 1 and 2 and often occur in nature as uncombined elements.

Transition elements are the elements in groups 3 through 12 in the periodic table. They are called transition elements because they are considered to be in transition between the main group elements. The main group elements are groups 1 and 2 and groups 13 through 18. Main group elements are sometimes called the representative elements.

(l)ImagemoreCo., Ltd./Alamy, (r)Kate Mathis/Getty Images

The Inner Transition Elements

The two rows of elements that seem to be disconnected from the rest of the periodic table are called the inner transition elements. They are called this because they fit within the transition metals on the periodic table. The inner transition elements are located between groups 3 and 4 in periods 6 and 7. To save room, they are usually listed below the table. The figure below shows what the periodic table would look like if the inner transition elements were not written below the table.



Metals in Earth's Crust

Earth's hardened outer layer, called the crust, contains many compounds and a few uncombined metals such as gold and copper. Metals that are found in Earth's crust are minerals. Minerals are often found in ores, as shown below. Ores are mixtures of minerals, clay, and rock that occur naturally in Earth's crust.

NPS photo by Michael Quinn

Assessment

1. When magnesium and fluorine react, what type of bond is formed?

metallic

B ionic **CORRECT**

covalent

diatomic

Assessment

2. What type of bond is found in pure gold?

A metallic **CORRECT**

ionic

covalent

diatomic

Assessment

3. Because electrons move freely in metals, metals are

 brittle.

 hard.

 dull.

D conductors. **CORRECT**

Assessment

5. Which elements are least reactive?

metals

halogens

C noble gases CORRECT

actinides

Section 2

Nonmetals

Essential Questions

- How do nonmetals bond?
- What properties of hydrogen make it a nonmetal?
- What are the properties and uses of the halogens?
- Why are noble gases unreactive?

Review Vocabulary

sublimation: the process of a solid changing directly to a vapor without forming a liquid

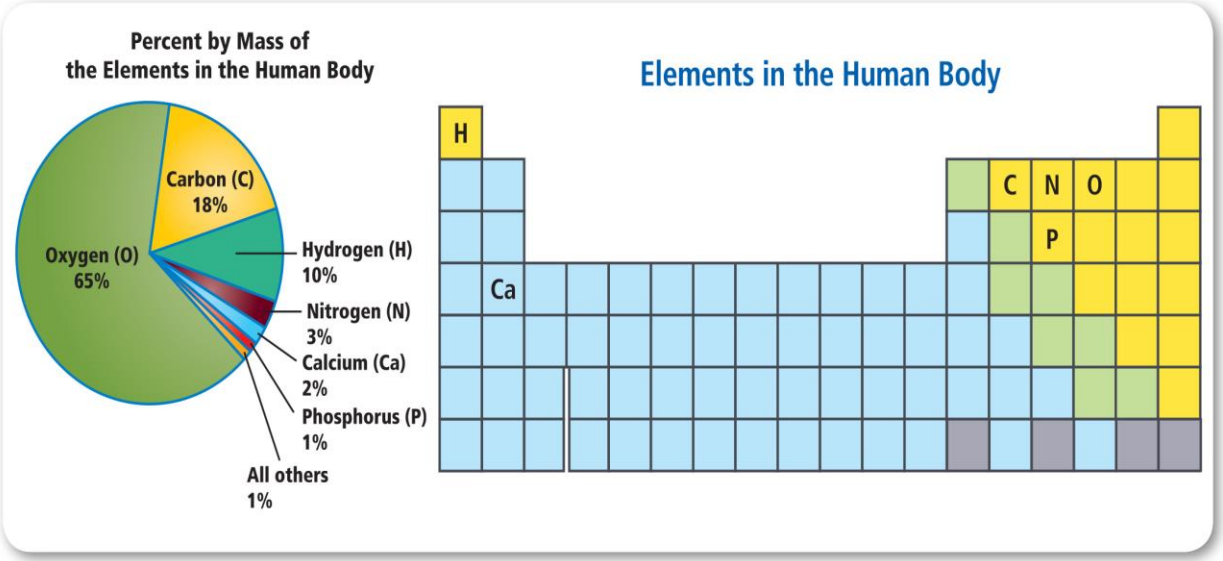
New Vocabulary

nonmetal 

diatomic molecule 

Properties of Nonmetals

Most of your body's mass is made of oxygen, carbon, hydrogen, and nitrogen, as shown below. Calcium, phosphorus, sulfur, and chlorine are among the other elements found in your body. Except for the metal calcium, these elements are nonmetals. Nonmetals are elements that are usually gases or solids at room temperature. Solid nonmetals are not malleable or ductile but are brittle or powdery. Nonmetals are poor conductors of heat and electricity because the electrons in nonmetals are not free to move as they do in metals.



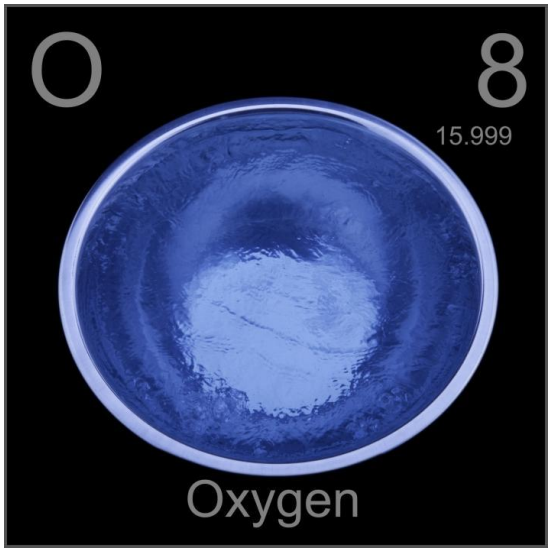
PROPERTIES OF NONMETALS

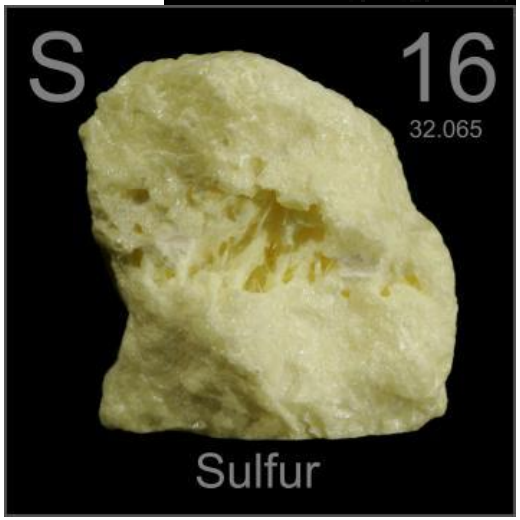
<u>Physical Properties</u>:

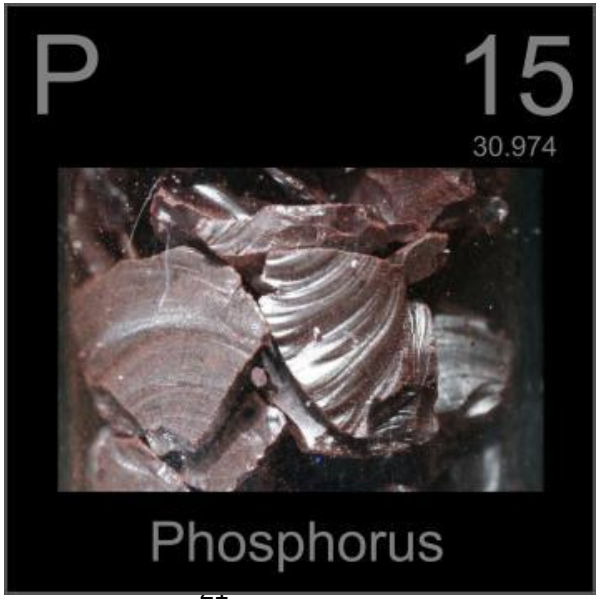
- Can be gas, solid, or liquid at room temperature
- Come in all colors
- No metallic luster
- Poor conductors
- Brittle
- Odors or pungent

<u>Chemical Properties</u>:

- Tend to gain electrons (makes negative ion)

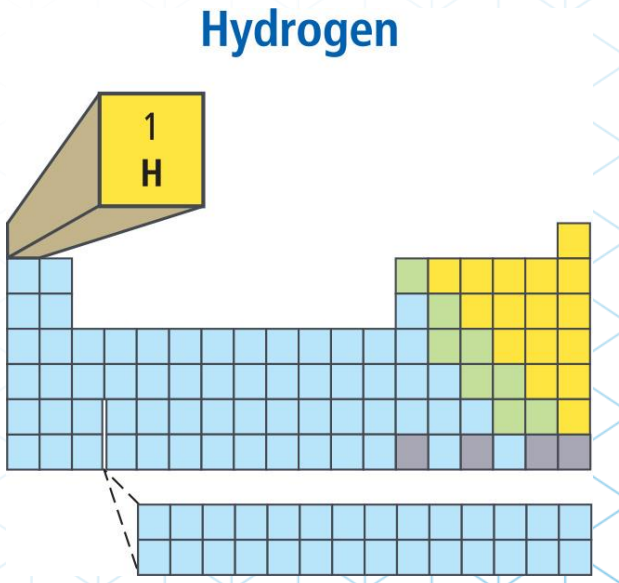






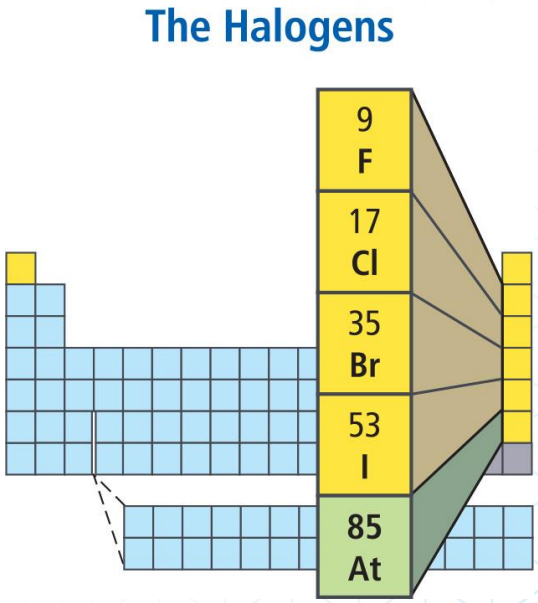
Hydrogen

If you could count all the atoms in the universe, you would find that about 90 percent of them are hydrogen atoms. Most hydrogen on Earth is found in the compound water. In fact, the word *hydrogen* comes from the Greek word *hydro*, which means "water." When water is broken down into its elements, hydrogen becomes a gas composed of diatomic molecules. A **diatomic molecule** consists of two atoms of the same element in a covalent bond.



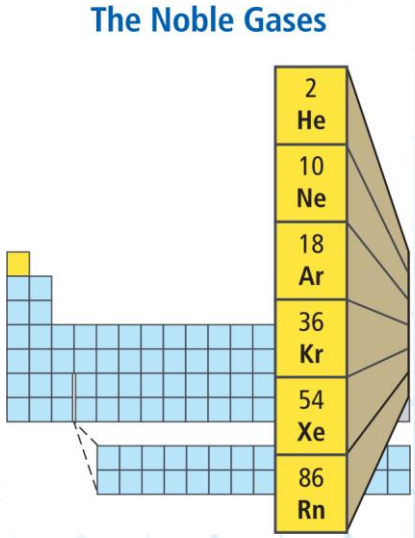
The Halogens

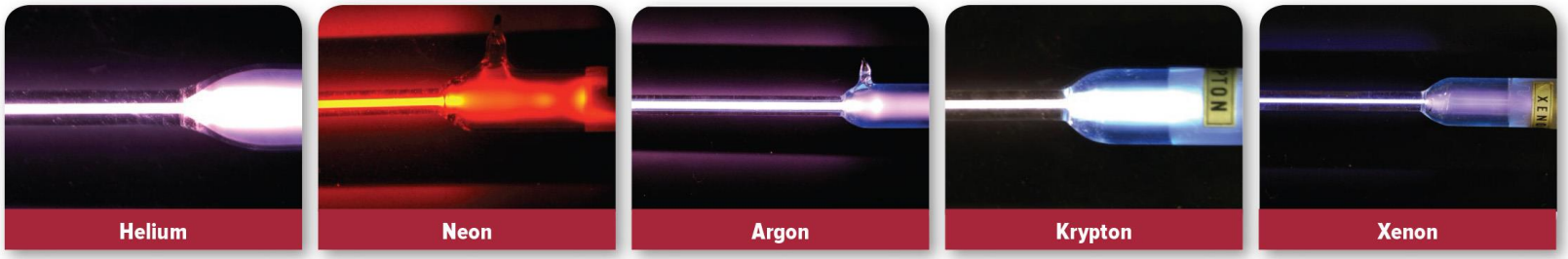
Fluorine, chlorine, bromine, iodine, and astatine are called halogens and make up group 17. They are very reactive in their elemental forms, and their compounds have many uses. For example, halogen lightbulbs contain small amounts of bromine or iodine vapor.



The Noble Gases

The noble gases exist as isolated atoms. They are stable because their outermost energy levels are full. No naturally occurring noble gas compounds are known, but several compounds of argon, krypton, and xenon, primarily with fluorine, have been created in a laboratory.





Mark Dierker/
McGraw-Hill Education

Assessment

1. Which element is the most reactive of all nonmetals?

A fluorine **CORRECT**

uranium

hydrogen

oxygen

Section 3

Mixed Groups

Essential Questions

- What are the differences between metals, nonmetals, and metalloids?
- How are the allotropes of carbon similar, and how are they different?
- What does the term *semiconductor* mean?
- What is the difference between natural and synthetic elements?

Review Vocabulary

substance: element or compound, that cannot be broken down into simpler components and still maintain its properties

New Vocabulary

metalloid 

allotrope 

semiconductor 

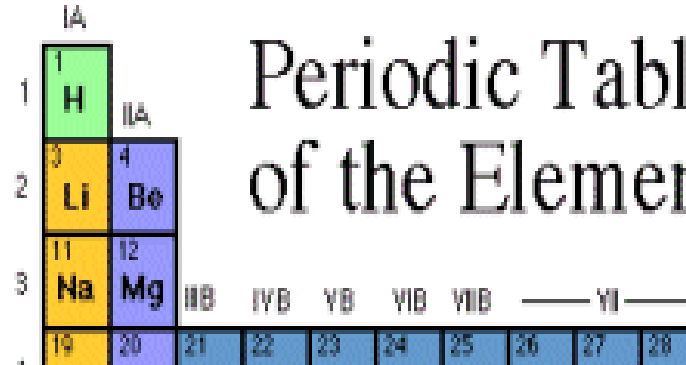
transuranium element 

Properties of Metalloids

Metalloids are elements that have some properties of metals and some properties of nonmetals. They can form ionic bonds and covalent bonds. Some metalloids can conduct electricity better than most nonmetals but not as well as many metals. The metalloids are located along the stair-step line on the periodic table. In this book, the metalloid element blocks are green. Groups 13 through 17 are mixed groups and contain metals, nonmetals, and metalloids

METALLOIDS

- Properties and characteristics of **both** metals and nonmetals
- Along the **staircase/steps** of th
- <u>EXCEPT</u>: Al, At

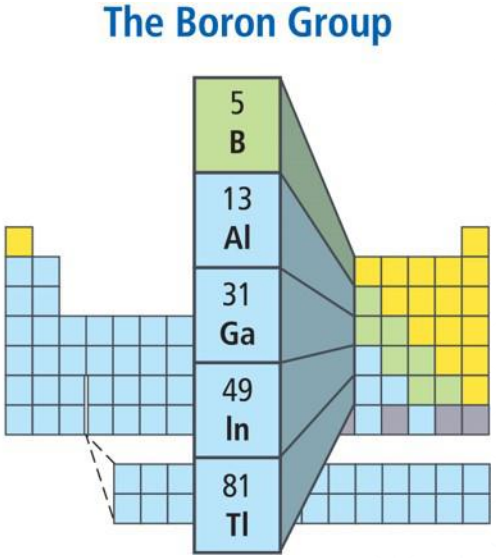


The Boron Group

Boron, a metalloid, is the first element in group 13. You might find the boron compounds borax and boric acid in your home. Borax is a water softener used in some laundry products. Boric acid is a mild antiseptic. Boron also is used to make heat-resistant glass, such as the lab equipment in the figure on the next screen.

The Boron Group

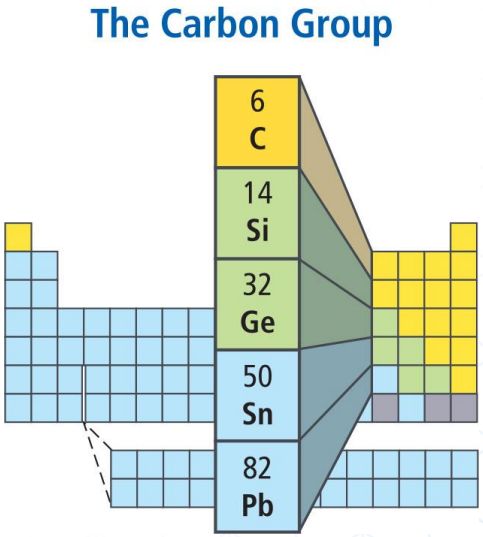
Aluminum, a metal in group 13, is the most abundant metal in Earth's crust. Because it is strong and light, aluminum is used in soft-drink cans, foil, pans, bicycle frames, and airplanes. Gallium is a metal used in electronic components. The last two group 13 elements are the rare metals indium and thallium.



Valentyn Volkov/Shutterstock.com

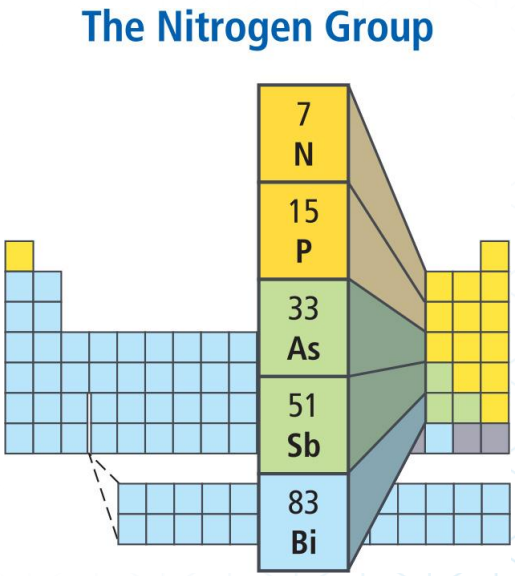
The Carbon Group

Each element in group 14, the carbon family, has four electrons in its outer energy level, but this is where much of the similarity ends. Carbon is a nonmetal, silicon and germanium are metalloids, and tin and lead are metals.



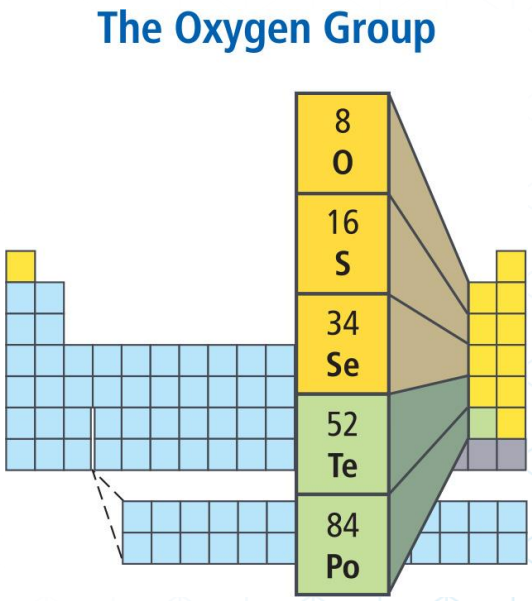
The Nitrogen Group

The nitrogen family makes up group 15. Each element has five electrons in its outer energy level. These elements tend to share electrons and form covalent compounds with other nonmetallic elements.



The Oxygen Group

Group 16 is the oxygen group. These elements have six electrons in their outer energy levels. They will accept two electrons from a metal or bond covalently with other nonmetals.

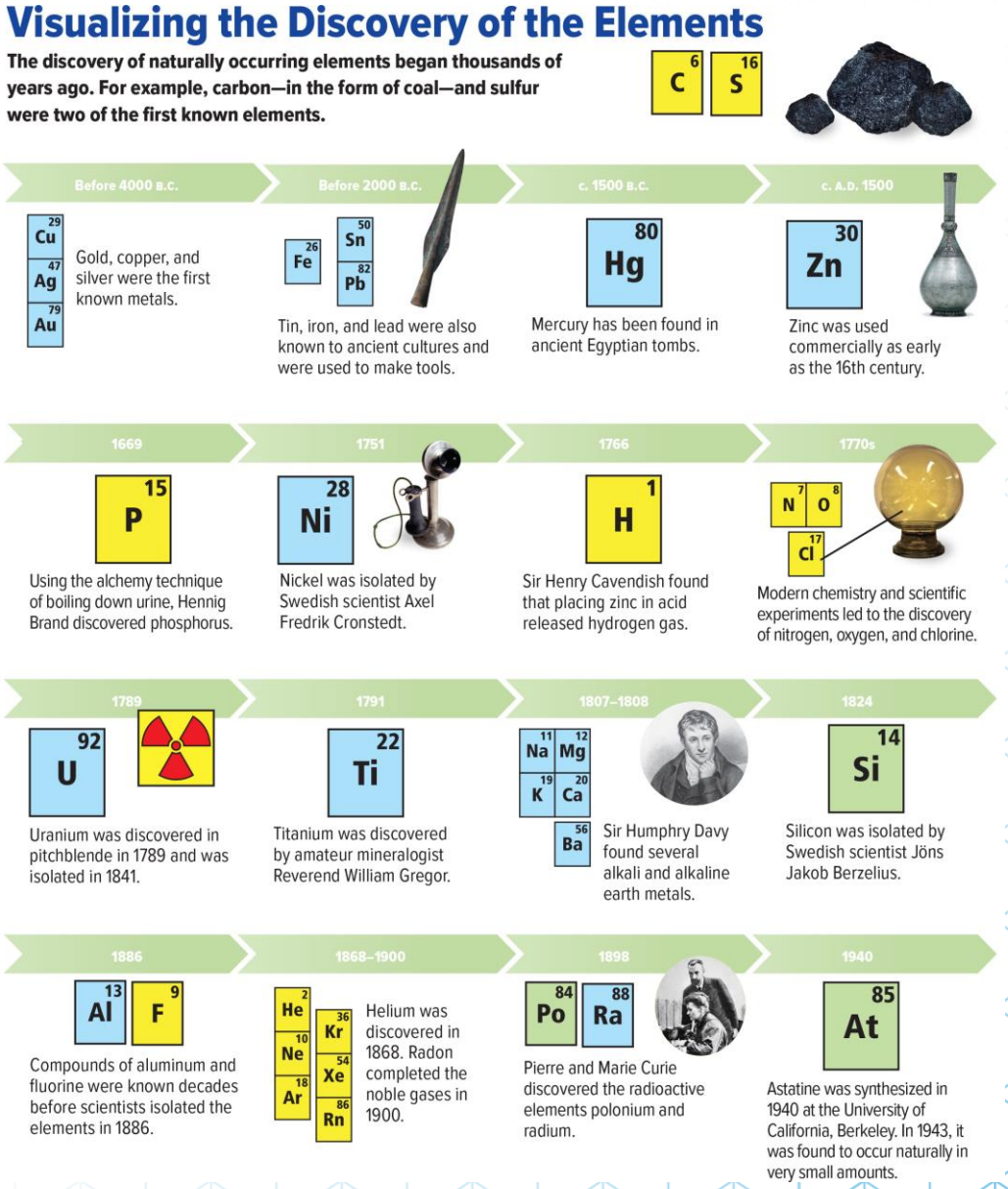


Discovering and Making Elements

The first elements known were those that occur naturally in their elemental forms, such as gold, lead, tin, and carbon. Gold, for example, has been known for at least 6,000 years. Most elements, however, were discovered after the birth of modern chemistry in the 1700s. The figure on the next page shows the history of the discovery of many common elements.

Discovering and Making Elements

The discovery of naturally occurring elements began thousands of years ago. For example, carbon—in the form of coal—and sulfur were two of the first known elements.



(l to r, t to b) Photodisc/Getty Images, DEA PICTURE LIBRARY/De Agostini Picture Library/Getty Images, Christie's Images Ltd./SuperStock, Ryan McVay/Getty Images, Joe Franek/McGraw-Hill Education, Hulton Archive/Getty Images, Popperfoto/Getty Images

PRACTICE!
METAL, NONMETAL, METALLOID

- Hydrogen — NONMETAL
- Magnesium — METAL
- Calcium — METAL
- Arsenic — METALLOID
- Carbon — NONMETAL
- Helium — NONMETAL
- Lead — METAL
- Aluminum — METAL

Assessment

1. Which set of elements makes up the most reactive group of all metals?


iron triad


coinage metals

C alkali metals

CORRECT


transition elements

Assessment

2. Which element is always found in nature combined with other elements?


copper


gold

C magnesium **CORRECT**


silver

Assessment

3. Neptunium (element 93) is part of which group of elements?

 halogens

 noble gases

 alkali earth metals

D inner transition elements

CORRECT