Key Terms

atomic mass
periodic table
metal
non-metal
metalloid
period
group

5.3 The Periodic Table

Most people have some type of collection, such as a stamp or butterfly collection, or even a sports memorabilia collection, like the one shown in **Figure 5.14**. In order to organize this collection of baseballs, some kind of plan needs to be used. For example, the baseballs could be organized according to the year they were obtained. Alternatively, they could be organized according to the teams that the players who signed them were on. In science, information needs to be organized to help scientists make conclusions or develop new hypotheses.

By the mid-1800s, chemists had discovered more than 50 elements and had determined properties of each. They needed a way to organize all the information, however.

Figure 5.14 When a collection gets too large to be manageable, people often organize the items in some way. How would you organize these baseballs?

Mendeleev's Arrangement of Elements

In the late 1860s, a Russian chemist named Dimitri Mendeleev organized known elements, looking for patterns in the properties. He finally found a pattern when he placed the elements in the order of increasing **atomic mass**. When Mendeleev used atomic mass to organize the elements, he noticed that properties repeated in a pattern that allowed the elements to be organized in a table. Because this organization showed the properties of elements in a pattern of regular intervals, or periodically, Mendeleev's organization of the elements came to be known as the **periodic table**.

Mendeleev left gaps in his table wherever there seemed to be a break in the pattern of the properties. This led to one of the most important features of Mendeleev's table: its usefulness for predicting properties of unknown elements based on the properties of known elements. Mendeleev made several predictions about the properties of unknown elements, which turned out to be correct.

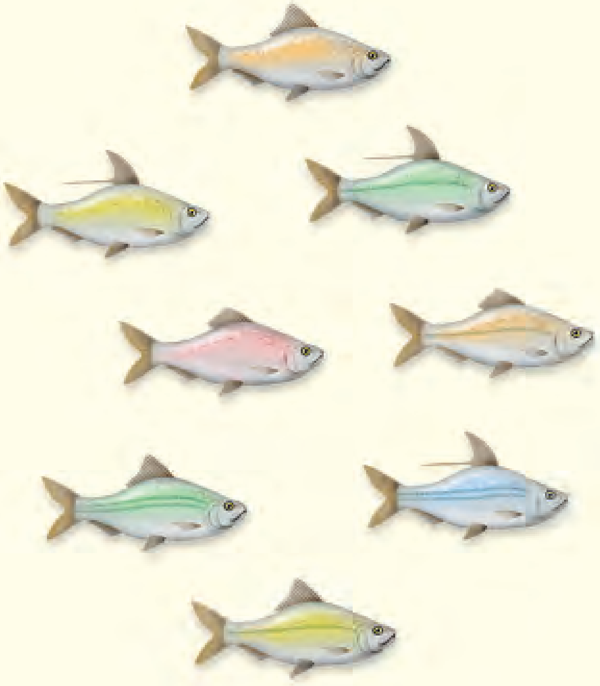
atomic mass the average mass of the naturally occurring isotopes of an element

periodic table a system for organizing the elements into columns and rows, so that elements with similar properties are in the same column

Activity 5-6

What's in Blackbock's Lake?

The water in Blackbock's Lake is very dark and cold, so you cannot see the bottom easily. The people who live near Blackbock's Lake say there are nine different types of fish in the lake. So far, biologists have found only eight types of fish. What might the missing ninth type of fish look like?



Procedure

1. Closely examine the eight fish in the diagram. Look for properties that vary from one fish to another. List the variable properties that you observe.
2. Create a table to organize your observations of the fish. Place similar properties in one row or column. Make your table as organized and consistent as possible.
3. Based on your table, predict the properties of the missing ninth fish.

Questions

1. Which part of this activity took the greatest amount of time and effort? Why?
2. What properties do you think the ninth fish should have? What did you have to assume about the ninth fish?
3. How is this activity similar to what scientists did when organizing the elements into a periodic table?

The Modern Periodic Table

Mendeleev's organization of the elements provided chemists with a valuable tool for studying the elements. Nevertheless, there were a few elements that Mendeleev had to put out of order. This problem was resolved after the discovery of the proton.

Today's periodic table, shown in **Figure 5.15**, is based on arrangement of the elements according to increasing atomic number. Notice how each element has its own box, which contains information about the element. Usually, the name, symbol, atomic number, and atomic mass of the element are included. The legend above the periodic table in **Figure 5.15** shows where this information is located in each box. Note, however, that the periodic table is not in standard atomic notation. The *ion charge* of the element is also included. Some atoms can lose or gain electrons, which makes the atoms become positively or negatively charged. You will look at ionic charges in more detail in Chapter 6, when you study the formation of compounds.

Figure 5.16 on pages 198 and 199 is a pictorial version of the periodic table. For many of the elements, a photograph is provided. What similarities and differences do you see among elements in each row and column?

Synthetic Elements

Go to **scienceontario** to find out more

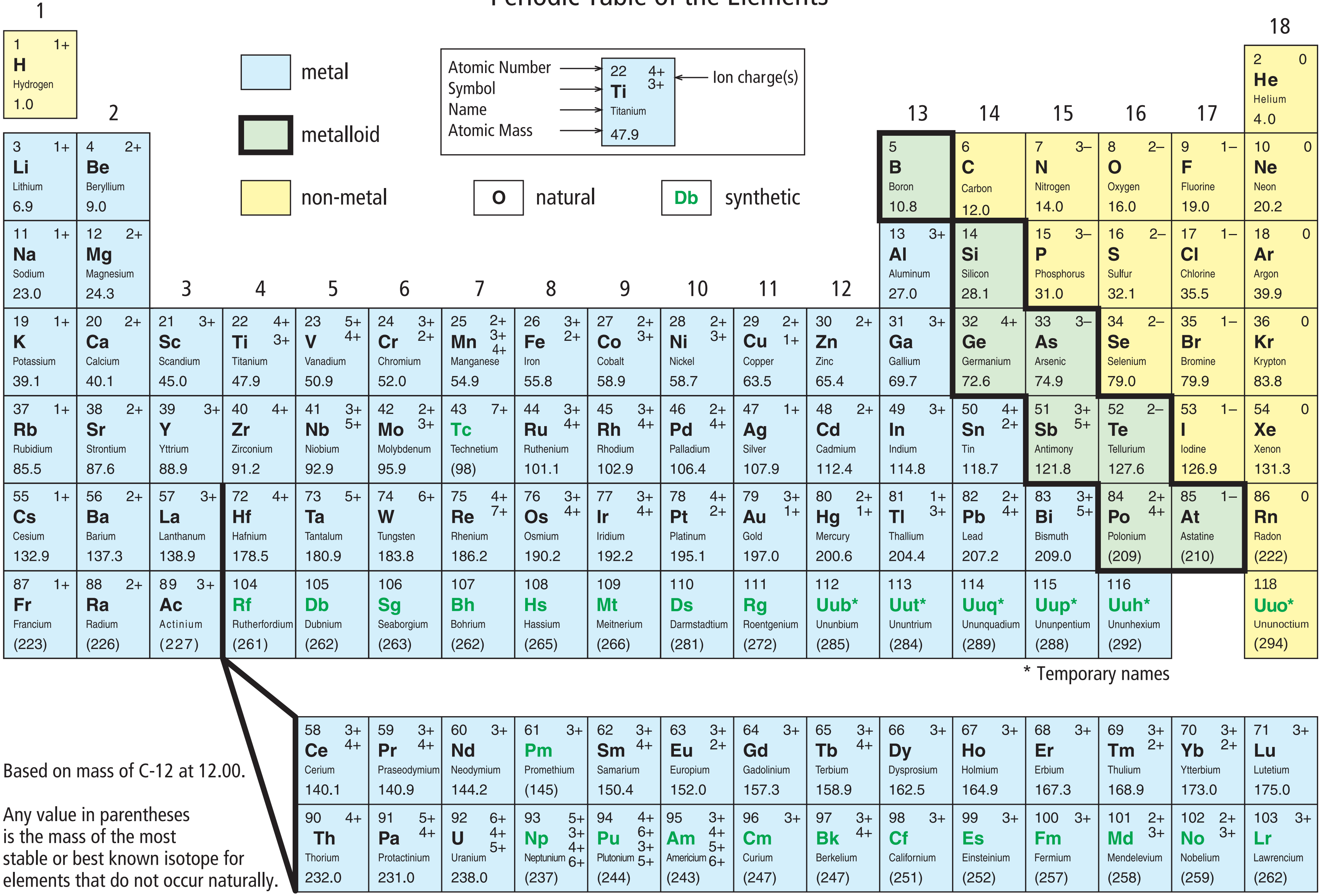
In the periodic table, most of the elements that have atomic numbers less than 93 are natural—they exist naturally on Earth. The other elements are synthetic—they have been made by scientists. Once the relationships between elements in the periodic table were established, scientists began to predict other elements that could be made. Their predictions were based on what the atomic structure of a synthesized element should be, according to its position in the periodic table. If you look at the names of the synthetic elements, you will see a few that include the names of familiar scientists: for example, curium, mendelevium, rutherfordium, and bohrium.

Today, scientists are still attempting to make new elements. One problem that scientists must always contend with, however, is that new elements are not usually very stable. A new element is often identified based on a single atom that exists for only a small fraction of a second!

Learning Check

1. Why did Mendeleev not consider the number of subatomic particles as a way to organize the elements?
2. How is the modern periodic table organized?
3. Using the periodic table, identify the chemical symbol, atomic number, and atomic mass of the element palladium.
4. Based on what you know about the model of the atom, why do you think new elements can be generated by smashing atoms together?

Periodic Table of the Elements



🟦 metal

🟩 metalloid

🟨 non-metal

Atomic Number → 22 4+ 3+ ← Ion charge(s)
Symbol → Ti
Name → Titanium
Atomic Mass → 47.9

O natural

Db synthetic

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 1+ **H** Hydrogen 1.0																	2 0 **He** Helium 4.0
2	3 1+ **Li** Lithium 6.9	4 2+ **Be** Beryllium 9.0											5 **B** Boron 10.8	6 **C** Carbon 12.0	7 3– **N** Nitrogen 14.0	8 2– **O** Oxygen 16.0	9 1– **F** Fluorine 19.0	10 0 **Ne** Neon 20.2
3	11 1+ **Na** Sodium 23.0	12 2+ **Mg** Magnesium 24.3											13 3+ **Al** Aluminum 27.0	14 **Si** Silicon 28.1	15 3– **P** Phosphorus 31.0	16 2– **S** Sulfur 32.1	17 1– **Cl** Chlorine 35.5	18 0 **Ar** Argon 39.9
4	19 1+ **K** Potassium 39.1	20 2+ **Ca** Calcium 40.1	21 3+ **Sc** Scandium 45.0	22 4+ 3+ **Ti** Titanium 47.9	23 5+ 4+ **V** Vanadium 50.9	24 3+ 2+ **Cr** Chromium 52.0	25 2+ 3+ 4+ **Mn** Manganese 54.9	26 3+ 2+ **Fe** Iron 55.8	27 2+ 3+ **Co** Cobalt 58.9	28 2+ 3+ **Ni** Nickel 58.7	29 2+ 1+ **Cu** Copper 63.5	30 2+ **Zn** Zinc 65.4	31 3+ **Ga** Gallium 69.7	32 4+ **Ge** Germanium 72.6	33 3– **As** Arsenic 74.9	34 2– **Se** Selenium 79.0	35 1– **Br** Bromine 79.9	36 0 **Kr** Krypton 83.8
5	37 1+ **Rb** Rubidium 85.5	38 2+ **Sr** Strontium 87.6	39 3+ **Y** Yttrium 88.9	40 4+ **Zr** Zirconium 91.2	41 3+ 5+ **Nb** Niobium 92.9	42 2+ 3+ **Mo** Molybdenum 95.9	43 7+ **Tc** Technetium (98)	44 3+ 4+ **Ru** Ruthenium 101.1	45 3+ 4+ **Rh** Rhodium 102.9	46 2+ 4+ **Pd** Palladium 106.4	47 1+ **Ag** Silver 107.9	48 2+ **Cd** Cadmium 112.4	49 3+ **In** Indium 114.8	50 4+ 2+ **Sn** Tin 118.7	51 3+ 5+ **Sb** Antimony 121.8	52 2– **Te** Tellurium 127.6	53 1– **I** Iodine 126.9	54 0 **Xe** Xenon 131.3
6	55 1+ **Cs** Cesium 132.9	56 2+ **Ba** Barium 137.3	57 3+ **La** Lanthanum 138.9	72 4+ **Hf** Hafnium 178.5	73 5+ **Ta** Tantalum 180.9	74 6+ **W** Tungsten 183.8	75 4+ 7+ **Re** Rhenium 186.2	76 3+ 4+ **Os** Osmium 190.2	77 3+ 4+ **Ir** Iridium 192.2	78 4+ 2+ **Pt** Platinum 195.1	79 3+ 1+ **Au** Gold 197.0	80 2+ 1+ **Hg** Mercury 200.6	81 1+ 3+ **Tl** Thallium 204.4	82 2+ 4+ **Pb** Lead 207.2	83 3+ 5+ **Bi** Bismuth 209.0	84 2+ 4+ **Po** Polonium (209)	85 1– **At** Astatine (210)	86 0 **Rn** Radon (222)
7	87 1+ **Fr** Francium (223)	88 2+ **Ra** Radium (226)	89 3+ **Ac** Actinium (227)	104 **Rf** Rutherfordium (261)	105 **Db** Dubnium (262)	106 **Sg** Seaborgium (263)	107 **Bh** Bohrium (262)	108 **Hs** Hassium (265)	109 **Mt** Meitnerium (266)	110 **Ds** Darmstadtium (281)	111 **Rg** Roentgenium (272)	112 **Uub*** Ununbium (285)	113 **Uut*** Ununtrium (284)	114 **Uuq*** Ununquadium (289)	115 **Uup*** Ununpentium (288)	116 **Uuh*** Ununhexium (292)		118 **Uuo*** Ununoctium (294)

* Temporary names

58 3+ 4+ **Ce** Cerium 140.1	59 3+ 4+ **Pr** Praseodymium 140.9	60 3+ **Nd** Neodymium 144.2	61 3+ **Pm** Promethium (145)	62 3+ 4+ **Sm** Samarium 150.4	63 3+ 2+ **Eu** Europium 152.0	64 3+ **Gd** Gadolinium 157.3	65 3+ 4+ **Tb** Terbium 158.9	66 3+ **Dy** Dysprosium 162.5	67 3+ **Ho** Holmium 164.9	68 3+ **Er** Erbium 167.3	69 3+ 2+ **Tm** Thulium 168.9	70 3+ 2+ **Yb** Ytterbium 173.0	71 3+ **Lu** Lutetium 175.0
90 4+ **Th** Thorium 232.0	91 5+ 4+ **Pa** Protactinium 231.0	92 6+ 4+ 5+ **U** Uranium 238.0	93 5+ 3+ 4+ 6+ **Np** Neptunium (237)	94 4+ 6+ 3+ 5+ **Pu** Plutonium (244)	95 3+ 4+ 5+ 6+ **Am** Americium (243)	96 3+ **Cm** Curium (247)	97 3+ 4+ **Bk** Berkelium (247)	98 3+ **Cf** Californium (251)	99 3+ **Es** Einsteinium (252)	100 3+ **Fm** Fermium (257)	101 2+ 3+ **Md** Mendelevium (258)	102 2+ 3+ **No** Nobelium (259)	103 3+ **Lr** Lawrencium (262)

Based on mass of C-12 at 12.00.

Any value in parentheses is the mass of the most stable or best known isotope for elements that do not occur naturally.

Figure 5.15 Today's periodic table is organized according to increasing atomic number.

Periodic Table of the Elements

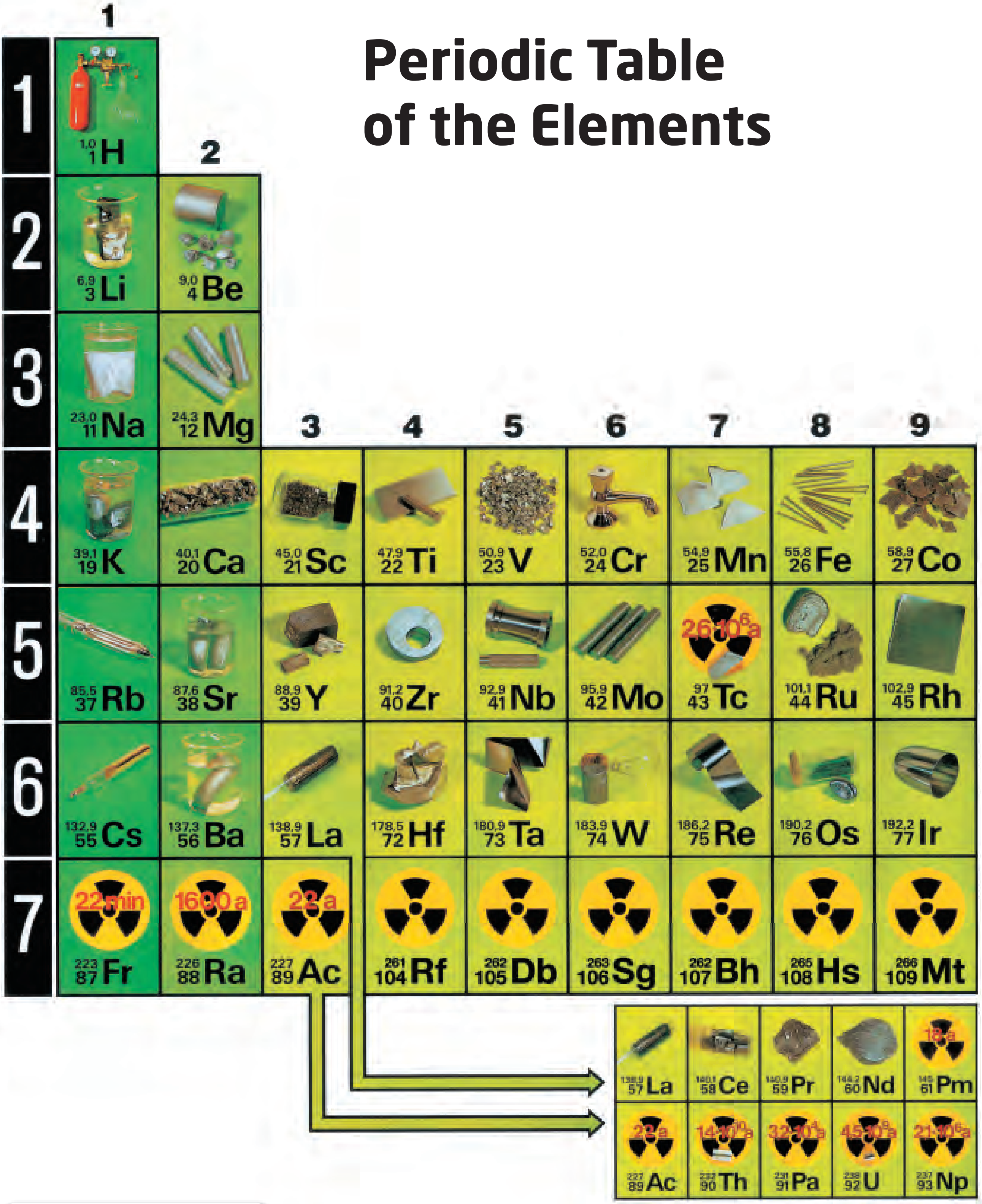
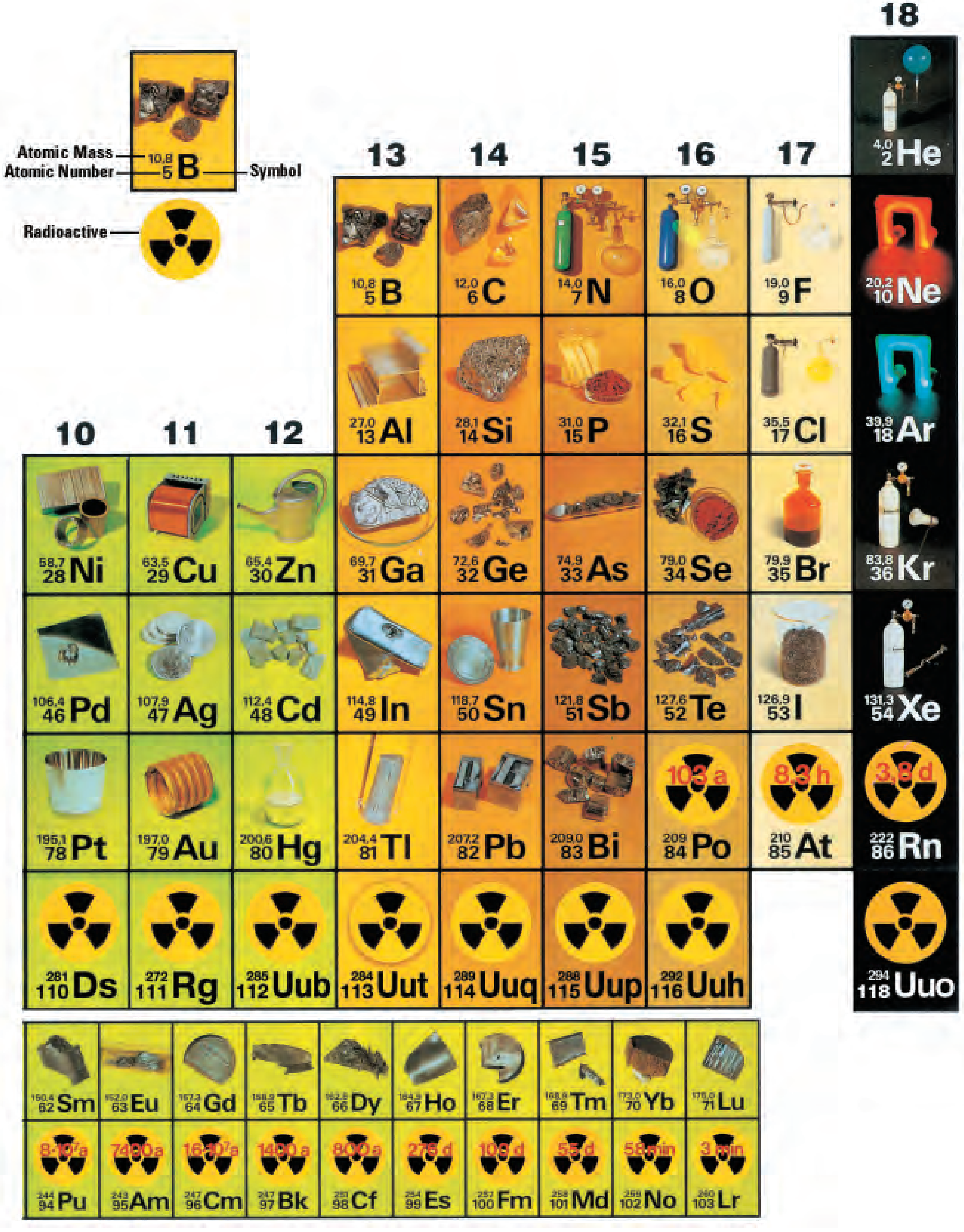


Figure 5.16 This periodic table provides a photographic representation for many of the elements.



10	11	12	13	14	15	16	17	18
								4,0 2 He
			10,8 5 B	12,0 6 C	14,0 7 N	16,0 8 O	19,0 9 F	20,2 10 Ne
			27,0 13 Al	28,1 14 Si	31,0 15 P	32,1 16 S	35,5 17 Cl	39,9 18 Ar
58,7 28 Ni	63,5 29 Cu	65,4 30 Zn	69,7 31 Ga	72,6 32 Ge	74,9 33 As	79,0 34 Se	79,9 35 Br	83,8 36 Kr
106,4 46 Pd	107,9 47 Ag	112,4 48 Cd	114,8 49 In	118,7 50 Sn	121,8 51 Sb	127,6 52 Te	126,9 53 I	131,3 54 Xe
195,1 78 Pt	197,0 79 Au	200,6 80 Hg	204,4 81 Tl	207,2 82 Pb	209,0 83 Bi	103 a 209 84 Po	8,3 h 210 85 At	3,8 d 222 86 Rn
281 110 Ds	272 111 Rg	285 112 Uub	284 113 Uut	289 114 Uuq	288 115 Uup	292 116 Uuh		294 118 Uuo

150,4 62 Sm	152,0 63 Eu	157,3 64 Gd	158,9 65 Tb	162,5 66 Dy	164,9 67 Ho	167,3 68 Er	168,9 69 Tm	173,0 70 Yb	175,0 71 Lu
$8\cdot10^{7}$a 244 94 Pu	7400a 243 95 Am	$16\cdot10^{7}$a 247 96 Cm	1400 a 247 97 Bk	800 a 251 98 Cf	276 d 254 99 Es	100 d 257 100 Fm	55 d 258 101 Md	58 min 259 102 No	3 min 260 103 Lr

Classes of Elements in the Periodic Table

The position of an element, relative to other elements in the periodic table, provides a way to predict the physical and chemical properties of the element.

Most of the elements are classified as either a **metal** or a **non-metal**, according to distinct properties. The shortened form of the periodic table in **Figure 5.17** shows where these two classes of elements appear in the periodic table. The elements on the left side of the periodic table (except hydrogen) are metals. The elements on the right side of the periodic table are non-metals. The properties of metals and non-metals are summarized in **Table 5.2**. Some of the properties of metals and non-metals are also represented in the pictorial periodic table in **Figure 5.16** (previous two pages).

Notice that there are several elements in **Figure 5.17** that fall in a diagonal line between the metals and the non-metals. These elements are called the **metalloids**. As their location in the periodic table suggests, they share some properties with metals (possibly shiny; solid at room temperature) and some properties with non-metals (brittle and not ductile; poor conductors of heat and electricity). **Figure 5.18**, on the page opposite, provides some interesting examples of elements that you probably know about, as well as some applications that you may not know about. If you look for these elements in the periodic table, you will see that they are all examples of metals.

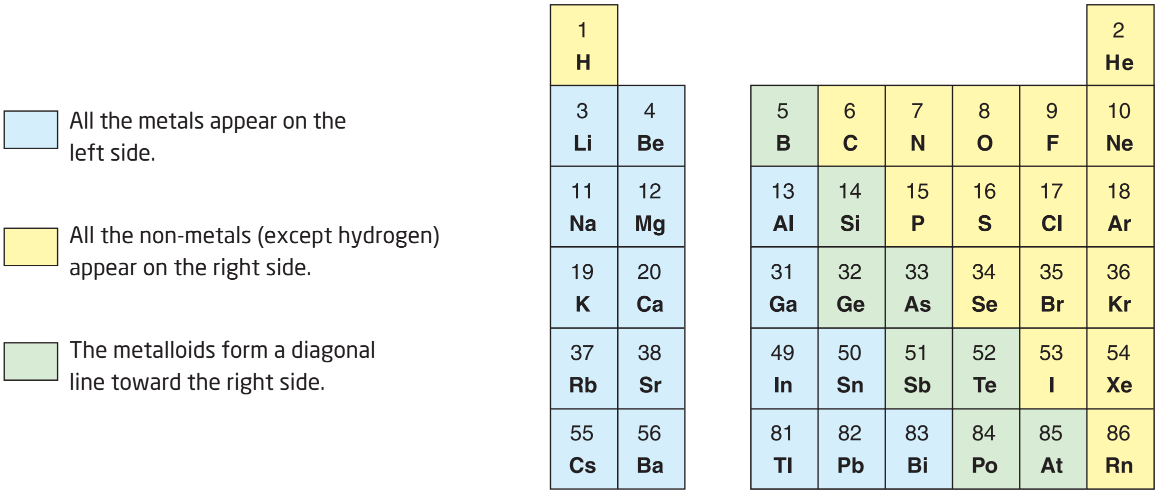
metal typically, an element that is hard, shiny, malleable, and ductile, and is a good conductor of heat and electricity

non-metal typically, an element that is not shiny, malleable, or ductile, and is a poor conductor of heat and electricity

metalloid an element that shares some properties with metals and some properties with non-metals

Table 5.2 Physical Properties of Metals and Non-metals

Material	State at Room Temperature (20°C)	Appearance	Conductivity	Malleability and Ductility
Metals	solid (except for mercury, which is a liquid)	shiny	good conductors of heat and electricity	malleable and ductile
Non-metals	some gases and some solids (except bromine, which is a liquid)	not very shiny	poor conductors of heat and electricity	brittle and not ductile



All the metals appear on the left side.

All the non-metals (except hydrogen) appear on the right side.

The metalloids form a diagonal line toward the right side.

1 H							2 He
3 Li	4 Be	5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn

Figure 5.17 The elements in the blue boxes are metals. The elements in the yellow boxes are non-metals. Metalloids are in the green boxes.

NATIONAL GEOGRAPHIC

VISUALIZING METALS

Figure 5.18

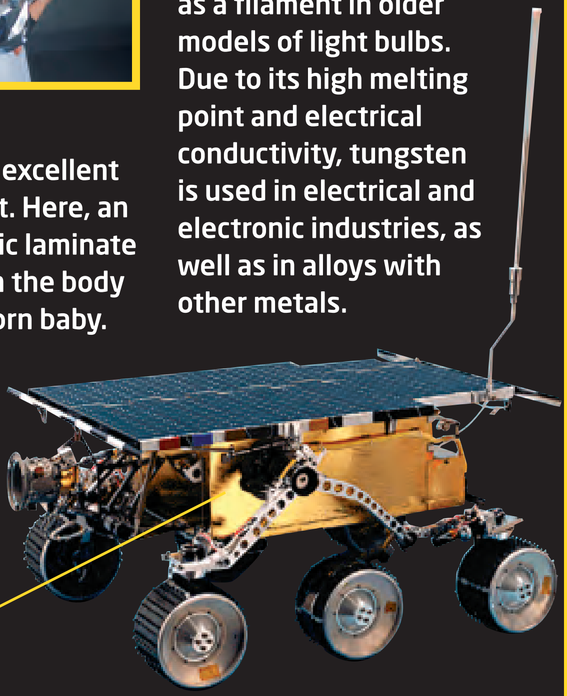
Most of us think of gold as a shiny yellow metal used to make jewellery. However, it is an element that is also used in more unexpected ways, such as in spacecraft parts. On the other hand, some less common elements, such as americium (am-uh-REE-see-um), are used in everyday objects. Some elements and their uses are shown here.

▲ **TITANIUM** (tie-TAY-nee-um) Parts of the exterior of the Guggenheim Museum in Bilbao, Spain, are made of titanium panels. Strong and lightweight, titanium is also used for body implants.

▲ **LEAD** Because lead has a high density, it is a good barrier to radiation. Dentists drape lead aprons on patients before taking X rays of the patient's teeth to reduce radiation exposure.

▲ **ALUMINUM** Aluminum is an excellent reflector of heat. Here, an aluminum plastic laminate is used to retain the body heat of a newborn baby.

▲ **TUNGSTEN** Tungsten has been used as a filament in older models of light bulbs. Due to its high melting point and electrical conductivity, tungsten is used in electrical and electronic industries, as well as in alloys with other metals.



▲ **GOLD** Gold's resistance to corrosion and its ability to reflect infrared radiation make it an excellent coating for space vehicles. The electronic box on the six-wheel Sojourner Rover, above, part of NASA's Pathfinder 1997 mission to Mars, is coated with gold.

◀ **AMERICIUM** Named after America, where it was first produced, americium is a component of this smoke detector. It is a radioactive metal that must be handled with care to avoid contact.

Mining for Metals

Some elements, such as gold and copper, are precious metals, easy to shape, and found in nature. Because of these properties, Aboriginal peoples have used them to make tools and ornaments for thousands of years. More recently, however, the mining of precious metals has had serious social and environmental impacts.

Today, gold mining relies a great deal on chemistry. The gold is extracted using a cyanide-based chemical to dissolve it. Not only do the mines disrupt the land and potentially harm ecosystems, but there is also a significant risk of the cyanide solution getting into the soil and ground water and contaminating surrounding areas. Cyanide is an extremely toxic substance for humans and wildlife.

Over 85 percent of the gold that is now mined is used for non-essential items, such as jewellery. This fact, combined with the serious environmental concerns associated with gold mining, have prompted many people to buy jewellery made from materials other than gold or to buy only recycled or vintage gold jewellery.

Sense of place

Bingham Canyon, in Utah, is a mine that produces copper, gold, molybdenum, and silver. It is 4 km across and 1.5 km deep, making it the world's largest open-pit mine. It is so large that it is visible from space.

STSE Case Study

Diamond Mining: Beyond the Sparkle

Canada's diamond mining industry is the third largest in the world, with an annual worth of over $1.5 billion. Although economically successful, diamond mines are located in ecologically sensitive environments that provide essential plant and wildlife resources for local Aboriginal peoples. Many people are asking whether the benefits of diamond mining outweigh the damage done to the environment.

Canada's first diamond mine, the Ekati Diamond Mine, opened in 1998. It is about 300 km from Yellowknife in the Northwest Territories.

Environmental Challenges

Diamond mines can be very disruptive to the surrounding land and waterways. Removal of huge amounts of soil and rock is required. Some diamonds lie beneath lakes, which need to be drained. Roads, airstrips, and power plants that are often built to service the mines can also affect the land. When lakes are drained or water quality changes, fish habitats can be affected. Also, wildlife is often displaced by mines.

Mining can produce large amounts of pollution and waste. Using electricity or fossil fuels, such as diesel, gas, and oil, creates gas emissions that contribute to pollution and climate change.

Meeting the Challenges

Efforts are being made to minimize the social and environmental challenges that are associated with diamond mining. Reclaiming the land that was mined can be done by saving the rock and soil that were removed and putting them back once the mining has stopped. Drained lakes can be refilled with water, and seeds from native plants can be harvested for replanting. The Diavik Diamond Mine monitors caribou, wolverine, grizzly bear, and raptor (bird of prey) activity to ensure minimal impact on local wildlife.

To conserve energy, the Ekati Diamond Mine has established an Energy Smart Program. It includes reducing the use of diesel fuel, recycling waste oil, and promoting energy saving among its employees.

Metals and Health

Metals are not only important economically. They are also part of essential processes in plants and animals. For example, iron is present in blood and is essential for oxygen transport throughout the human body. In fact, iron is present in every body cell, where it is used for important reactions. Other metals that are essential for plants and animals include copper, zinc, magnesium, and calcium.

Metals at too high a level, however, can be harmful. For example, people who must undergo multiple blood transfusions over a period of time can accumulate too much iron, which is present in the transfused blood. This can cause iron to accumulate in the body and severely harm the heart and liver. Exposure to toxic metals in the environment can also occur. Like DDT, which was discussed in Chapter 4, certain metals can bioaccumulate and biomagnify. These metals tend to accumulate in the organs of animals, especially the kidneys and liver. This accumulation can ultimately damage the organs. Some of the toxic metals in the environment include arsenic, aluminum, lead, and mercury.

Suggested Investigation

Inquiry Investigation 5-B, Physical Properties of Metals and Non-metals, on page 213

Sense of place

The American eel was once an important food source for Aboriginal peoples in eastern Canada. These eels now show elevated levels of toxins and metals.

Diamond Mines and Local Communities

Canada's five diamond mines contribute in many ways to the local communities:

- Some diamond mines are governed by agreements that provide social benefits to the communities, such as training and community programs.
- When possible, local people are hired to work at diamond mines or in support industries, such as maintenance, catering, and transportation.
- Mining companies give donations to local communities and sponsor community events and scholarships.
- Some diamond mines have business venture development programs to encourage the success of local businesses.

Your Turn

1. Make a PMI (plus, minus, interesting) chart for diamond mining in Canada, based on what you have read.
2. BHP Billiton, Rio Tinto, Tahera, and De Beers are companies that own diamond mines in Canada. Research one of these companies. Report what steps, if any, the company is taking to minimize the social and environmental challenges that are associated with diamond mining.
3. Suppose that you are a newspaper reporter who has been assigned to write an article about the social and environmental effects of mining. Choose a metal that is mined in Ontario, such as nickel, gold, silver, or platinum. Research and write an article about the mining industry for the metal you chose. Make sure that you discuss both positive and negative effects of the industry. You can use this case study about diamond mining as a model.

Study Toolkit

Visualizing As you read this page, visualize how mercury poisoning can occur in aquatic environments. Use the steps outlined in the table on page 178 for this visualization process.

Mercury Pollution of Aboriginal Lands

Although some mercury occurs naturally, most of the mercury in the environment is the result of human activities. These activities include burning waste materials and fossil fuels, such as oil and coal, as well as other industrial operations. Animals do not easily take up mercury when it is present on its own. Some bacteria, however, can convert elemental mercury to a form called methyl mercury, which can be taken up by animals. These bacteria are most active in aquatic environments. This is why waterways are a key source of mercury poisoning.

For centuries, Aboriginal peoples have lived off the land, as shown in **Figure 5.19**. Since the 1970s, however, high levels of mercury have been measured in many of the waterways on Aboriginal lands, particularly in northwestern Ontario. Methyl mercury has contaminated drinking water sources and fish that inhabit the lakes and rivers. This mercury poisoning has been devastating to Aboriginal communities. It has caused severe illnesses in many people, and it has forced communities to stop the important traditional practice of fishing. Fishing represents not only an important source of food for the communities, but also an important source of income through commercial fishing.

Figure 5.19 Fishing has been an important traditional practice for Aboriginal peoples. It has been threatened by the presence of mercury in waterways on Indigenous lands.

Making a Difference

Fluorescent tubes are popular alternatives to conventional light bulbs. The tubes, however, contain mercury, which is toxic to the environment. Many tubes are not recycled and end up in landfills. Hamilton student Patrick Bowman was in Grade 7 when he studied the issue for his science fair project. He learned that up to 1 350 000 mg of mercury from fluorescent tubes enter his city's landfill each year.

To determine the effects these tubes might have on the environment, Patrick made two model landfills using compost. He put broken tubes into one landfill and left the other uncontaminated. He added rainwater to the landfills to model leachate, a liquid produced when precipitation and landfill waste mix. Patrick found that the uncontaminated landfill and leachate supported plant growth and micro-organism life better than the contaminated landfill and leachate. His project "Shedding the Lights from Landfill Sites" won several awards at the 2006 Canada Wide Science Fair.

How could you help raise your community's awareness of the hazards associated with the disposal of fluorescent tubes?

Periods and Groups in the Periodic Table

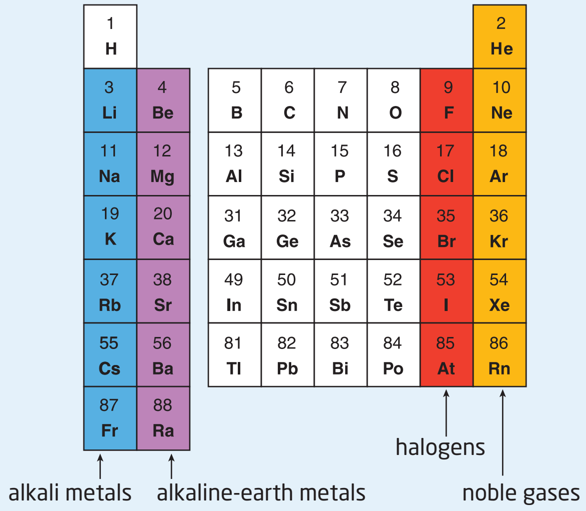
As you have seen, elements are listed in the periodic table by increasing order of atomic number. You can describe the position of an element in the periodic table by giving its period and group. A horizontal row in the periodic table is a **period**. The periods are numbered from 1 to 7, beginning in the first row of the periodic table and moving downward. A vertical column in the periodic table is a **group**. The groups are numbered from 1 to 18, beginning at the left-hand side of the periodic table and moving across to the right-hand side. A group is also called a family because the elements in a group tend to have very similar physical and chemical properties. If you look back at **Figure 5.15** on page 197, you will see the group and period numbers in the periodic table.

Four well-known groups are the alkali metals, the alkaline-earth metals, the halogens, and the noble gases. **Figure 5.20** shows examples of elements from each of these groups and highlights the important properties of each group.

period a horizontal row of elements in the periodic table

group a vertical column of elements in the periodic table

Figure 5.20 The alkali metals, alkaline-earth metals, halogens, and noble gases have characteristic properties.



1 H							2 He
3 Li	4 Be	5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra						

Halogens The halogens are the elements in Group 17. These non-metals are highly reactive and extremely corrosive. As you move from fluorine (at the top of the group) to iodine, the melting points increase. As shown here, fluorine (A) and chlorine (B) are gases, bromine (C) is a liquid, and iodine (D) is a solid at room temperature. Chlorine and iodine are both used as disinfectants. Chlorine is often used to help kill bacteria in swimming pools.

Alkali Metals The alkali metals are the elements in Group 1 (except for hydrogen). These metals have low melting points. Like the freshly cut sodium shown, they are soft enough to be cut with a knife. They are highly reactive. In fact, these metals are usually stored in kerosene or oil to keep water and oxygen away.

Alkaline-Earth Metals The alkaline-earth metals are the elements in Group 2. These metals are highly reactive, but they are less reactive than the alkali metals. If they are heated, they will burn in air. Because they produce bright, colourful flames, the alkaline-earth metals and their compounds are often used in fireworks. Magnesium, shown here, burns with a bright, white light.

Noble Gases The noble gases are the elements in Group 18. These non-metals are all odourless, colourless gases at room temperature. The main property that defines this group, however, is their non-reactivity. The hot metal filament in a light bulb will not react with a noble gas. Therefore, energy-efficient light bulbs, like the one shown here, are filled with argon to extend the life of the filament.

Section 5.3 Review

Section Summary

- The modern periodic table is organized according to the atomic numbers of the elements. When the elements are arranged in order of increasing atomic number, there is a regular repeating pattern in the properties of the elements.
- The three main classes of elements are metals, non-metals, and metalloids. Metals are usually solids at room temperature, shiny, good conductors, malleable, and ductile. Non-metals are usually gases or solids at room temperature, not shiny, poor conductors, brittle, and not ductile. Metalloids share properties of both metals and non-metals.
- Poisoning by metals in the environment is a serious problem. Mercury contamination of fish has severely affected the health and traditional practices of Aboriginal peoples.
- In the periodic table, a period is a horizontal row of elements. A group, or family, is a vertical column of elements. Elements that are in the same group have similar properties. Four major groups of elements in the periodic table are the alkali metals, alkaline-earth metals, halogens, and noble gases.

Review Questions

T/I **1.** How did Mendeleev's work help in the discovery of new elements?

K/U **2.** Identify the full name, atomic number, and atomic mass of each element, using the periodic table in **Figure 5.15**.

a. K **b.** P **c.** N

K/U **3.** What properties are associated with metals?

T/I **4.** How has the presence of mercury in the waterways of northern Ontario affected the environment and lives of Aboriginal peoples?

K/U **5.** What group of elements consists of non-reactive non-metals?

C **6.** A new scam on the Internet involves people selling samples of sodium that they collected from a secret river in the mountains. Write a short statement to explain why this is a scam.

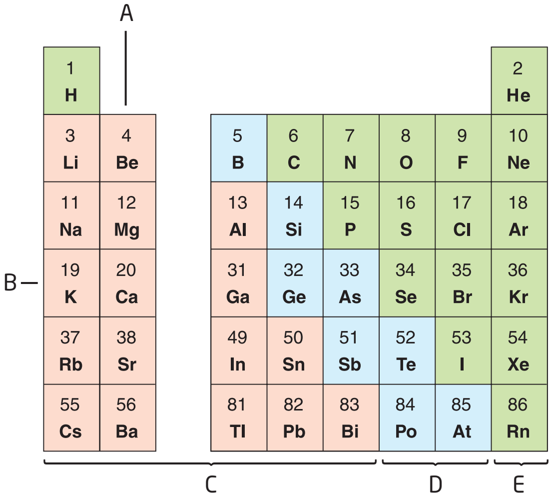
K/U **7.** Identify the features of the periodic table on the right, which are indicated by labels A to E.

A **8.** What element is at each of the following positions in the periodic table in **Figure 5.15** on page 197? Provide the full name and symbol.

a. Group 2, Period 3

b. Group 14, Period 2

c. Group 18, Period 4



The periodic table is organized into regions with characteristic features.