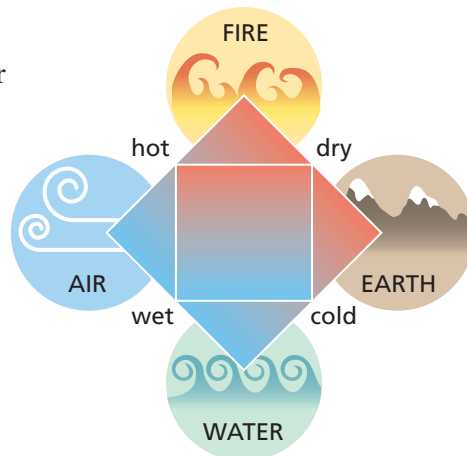


The Elements

Key Ideas

Ancient chemistry provided practical information, but not a good understanding of matter.

- Ancient chemistry was about either the practical use of materials or their connection with the spiritual world.
- Thinking of matter as combinations of only four elements limited new learning about chemistry for many centuries.
- A new era of chemistry began when scientists started to observe and experiment.



Modern chemists began to find and name new elements and compounds, and developed a universal system for naming elements and compounds.

- The modern chemists started to do experiments and hastened the discovery of elements and compounds.
- Observation and experimentation were used to see if substances could be broken down. New elements were identified when substances could not be broken down further.
- The system Berzelius developed gave all elements and compounds a unique symbol.
- The new language of elements and compounds enabled chemists to discuss and share what they learned more easily.

Vocabulary

metals, p. 190

non-metals, p. 191

metalloids, p. 191

Name	Symbol	Name	Symbol	Name	Symbol	Name	Symbol
aluminum	Al	chromium	Cr	indium	In	oxygen	O
antimony	Sb	cobalt	Co	iodine	I	palladium	Pd
arsenic	As	copper	Cu	iron	Fe	phosphorus	P

Elements can be classified into three categories: metals, non-metals, and metalloids.

- Although each element is unique, all the elements can be classified into three main groups that share some of the same properties.
- The majority of all elements are metals, sharing the properties of lustre, electrical and heat conductivity, malleability, and ductility.
- Elements in the smaller, but equally important, group of non-metals mainly share the characteristic that they lack the properties of metals.
- Metalloids are between the metals and the non-metals. They share some of the properties of both groups.



The Periodic Table orders the elements into groups with the same properties.

- Dmitri Mendeleev developed a table based on the increasing mass of the elements and on the repeating properties of groups of elements.
- The Periodic Table was able to predict new elements that had not yet been discovered.

Groups	I	II	III	IV	V	VI	VII	VIII	
Formulas of Compound	R_2O	RO	R_2O_3	RO_2 H_4R	R_2O_5 H_3R	RO_3 H_2R	R_2O_7 HR	RO_4	
Periods	1	H(1)							
	2	Li(7)	Be(9.4)	B(11)	C(12)	N(14)	O(16)	F(19)	
	3	Na(23)	Mg(24)	Al(27.3)	Si(28)	P(31)	S(32)	Cl(35.5)	
	4	K(39)	Ca(40)	—(44)	Ti(48)	V(51)	Cr(52)	Mn(55)	Fe(56) Co(59) Ni(59) Cu(63)
	5	[Cu(63)]	Zn(65)	—(68)	—(72)	As(75)	Se(78)	Br(80)	
	6	Rb(85)	Sr(87)	?Yt(88)	Zr(90)	Nb(94)	Mo(96)	—(100)	Ru(104) Rh(104) Pd(105) Ag(108)
	7	[Ag(108)]	Cd(112)	In(113)	Sn(118)	Sb(122)	Te(125)	I(127)	

Review Key Ideas and Vocabulary

- Which substance was not one of the Greek elements?
(a) air (c) wood
(b) water (d) earth
- Which element is not correctly matched with its symbol?
(a) oxygen O
(b) beryllium Be
(c) nitrogen Ni
(d) sodium Na
- Which of the following elements is represented by the symbol “S”?
(a) silver (c) silicon
(b) sulfur (d) sodium
- Which of the following is a characteristic of non-metals?
(a) low lustre
(b) malleable
(c) very ductile
(d) high electrical conductivity
- Which scientist is credited with the invention of the Periodic Table?
(a) A Lavoisier
(b) J.J. Berzelius
(c) D.I. Mendeleev
(d) Joseph Priestley
- List five elements named for geographical locations and give the names of the locations.
- Match each symbol with the metal it represents.

Symbol	Element
(a) Rn	iodine
(b) Si	potassium
(c) Cd	calcium
(d) P	silver
(e) K	iron
(f) Fe	phosphorus
(g) I	silicon
(h) Ca	radium
(i) Ra	cadmium
(j) Ag	radon


- Identify each of the following statements as true (T) or false (F). Correct the false statements to make them true.
(a) The early study of natural substances was called alchemy.
(b) The main goal of alchemists was to share their ideas.
(c) Elements are made of compounds.
(d) Mendeleev organized elements by properties.
(e) Elements in the same period have the same properties.
(f) Metals are dull and poor conductors of electricity.
- Explain the difference between a period and a group in the Periodic Table.
- A new element has been discovered. All you know at this point is that it is a metal. Based on this information, predict the following:
(a) its state at room temperature
(b) whether it will be shiny or dull
(c) whether it will be brittle or malleable
(d) whether it will conduct electricity or not
- A new element has been discovered that is solid, brittle, and shiny, and it conducts electricity. To which group of elements does it belong? Explain your answer.
- Which group of elements—metals, non-metals, or metalloids—is used to create the semiconductors needed by cell phones and computers?
- Name an unknown element that Mendeleev predicted would be discovered, based on his understanding of the properties of groups of elements.
- What happened when the symbols and language of chemistry were developed and shared?

Use What You've Learned

- Aspartame, the sugar substitute in diet pop, has the formula $C_{14}H_{18}N_2O_5$. Which elements are contained in aspartame, and in what proportions? The formula for sugar (sucrose) is $C_{12}H_{22}O_{11}$. What are the elements in sugar and their proportions?

16. The information in Table 1 has been scrambled. Draw a similar table in your notebook, but place the matching formulas, elements, and proportions in the correct rows.

Formula	Element	Proportion
KF	sodium and sulfur	1 to 1
Al ₂ S ₃	potassium and fluorine	1 to 2
CaCl ₂	calcium and oxygen	2 to 1
Na ₂ S	aluminum and sulfur	1 to 1
CaO	calcium and chlorine	2 to 3

17. Why do you think the noble gases were the last family to be discovered?
18. Mercury is the only metal that is a liquid at room temperature. What properties do you think mercury has that make it a metal?
19. Which heavenly bodies were the following elements named after: mercury, uranium, neptunium, plutonium, tellurium, selenium, palladium, and cerium? You may need to do some research for some.
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20. A nail head in a seat in a sauna feels very hot. The wood of the seat feels only warm. Since they are in the same sauna at the same temperature, what causes the difference?
21. Imagine that you have a collection of stamps from around the world. Some of the stamps are very old, dating back to almost the first stamps of 1840. You want to display the stamps so that people can appreciate both how old the stamps are and where they are from. Based on your understanding of the Periodic Table, explain how you might organize the collection.

Think Critically

22. The beginning of modern chemistry was an exciting time. Research one of the scientists mentioned in this chapter, and write a one-page report about the contributions he made to the understanding of chemistry.

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23. Many elements are mined to make them available for use. Where might we have to look for these elements if we can no longer find them through conventional mining?
24. Why do you think properties such as colour and taste were not used to arrange elements in the first periodic table?
25. Kryptonite is the green substance harmful to the fictional character Superman. Research the properties of krypton, and decide if the two substances are likely the same.

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26. The Periodic Table that we use today has a very recognizable form, but it is only one of the forms that have been created. Use the Internet to find alternative forms. Research one and write a report, create a poster, or do a PowerPoint presentation to share your chosen form.

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27. Elements in the same group have similar properties. Describe two examples in everyday life where similar substances could be substituted for each other. What other factors would you consider before making the substitution?

Reflect on Your Learning

28. Berzelius's symbols and Mendeleev's Periodic Table are testaments to the power of grouping and classification. Make a table to show the important points in Chapter 6. Does organizing information in this way help you understand or remember the information better?

Visit the Quiz Centre at

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