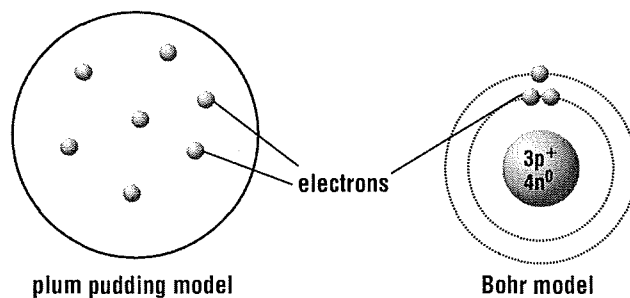


SUGGESTED ANSWERS

WHAT DO YOU REMEMBER?

- Iodine belongs to the halogen family, which is found in column 17.
 - Barium belongs to the alkaline earth metals, which are found in column 2.
 - Francium belongs to the alkali metals, which are found in column 1.
 - Krypton belongs to the noble gases, which are found in column 18.
- The staircase divides the metallic elements from the non-metallic elements.
- Dmitri Mendeleev designed the early periodic table.
- Elements are listed in rows in order of increasing atomic number such that elements in columns have similar properties.
- An element cannot be broken down into simpler substances by physical or chemical means, but compounds are chemical combinations of elements and can be broken down by chemical means.
 - A group is a column in the periodic table, whereas a period is a row.
 - A metal is shiny, often workable (malleable or ductile), and is often a good conductor of thermal energy and electricity. A non-metal may be a gas or a dull solid under normal conditions, is likely to be a poor conductor of thermal energy and electricity, and, if solid, is usually brittle.
 - A proton is positively charged, and a neutron has no net charge.
 - An electron has a negative charge, which is opposite to the charge on the proton.
 - Atomic number is equal to the number of protons in an atom, whereas atomic mass is the combined mass of all of the particles in an atom.
- Both the pudding model and the Bohr model have electrons inside the atom. In the pudding model, though, the electrons are spread out evenly in a cloud of positive charge, whereas in the Bohr model, the electrons are restricted to traveling in certain allowed orbits around a nucleus.



- Seeing that the tiny positively charged particles he fired at gold atoms in a thin foil usually were undeflected, but occasionally deflected at large angles, Rutherford concluded that atoms were mostly empty space with a tiny, positively charged nucleus.

WHAT DO YOU UNDERSTAND?

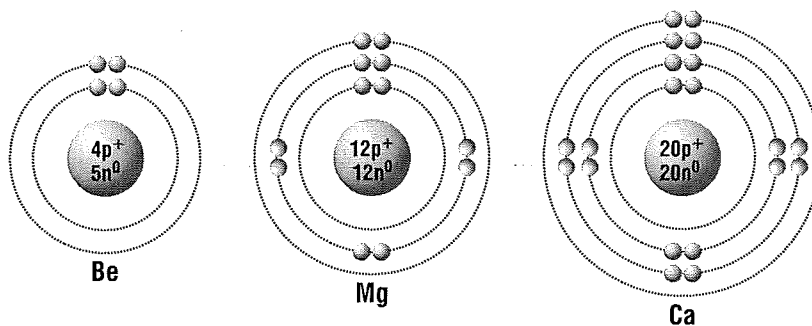
- The modern model of the atom disagrees with Dalton's model in that atoms have smaller particles inside (electrons, protons, and neutrons) and are not like tiny billiard balls.

9. Thomson discovered that extremely small particles are emitted by electrified metals in cathode ray tubes. These particles are attracted to positive charge and thus must be negatively charged.

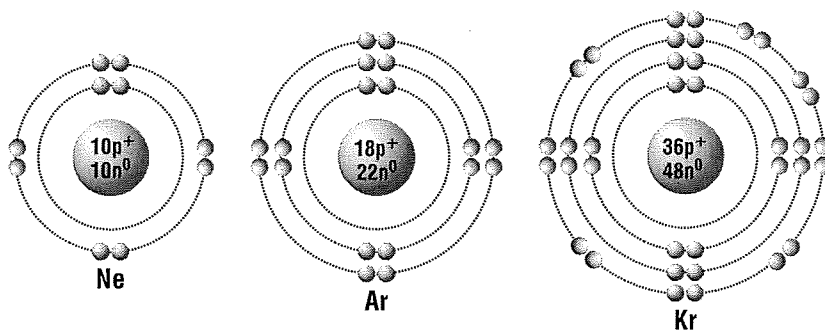
10. **Table 1**

Element name	Element symbol	Atomic number	Mass number	Number of protons	Number of neutrons	Number of electrons
manganese	Mn	25	55	25	30	25
tantalum	Ta	73	181	73	108	73
mercury	Hg	80	201	80	121	80
krypton	Kr	36	84	36	48	36
phosphorus	P	15	31	15	16	15

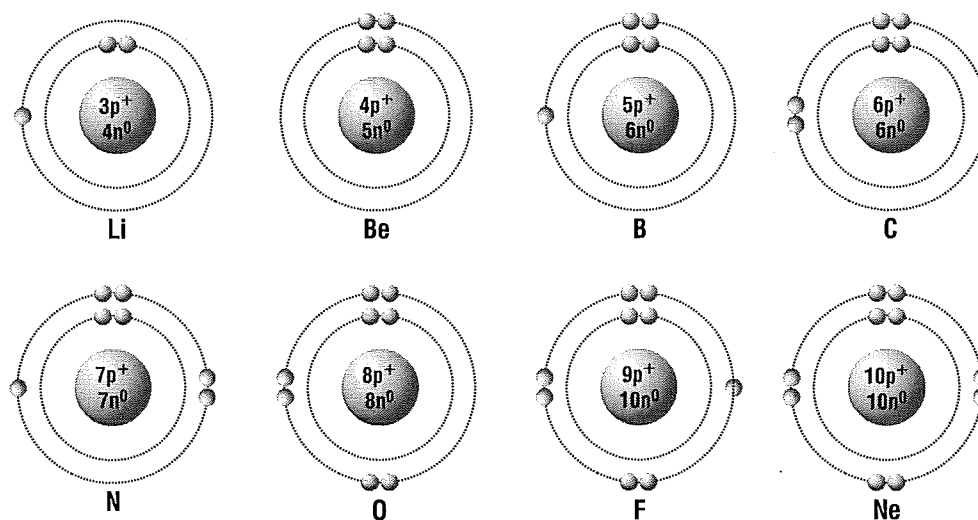
11. (a)

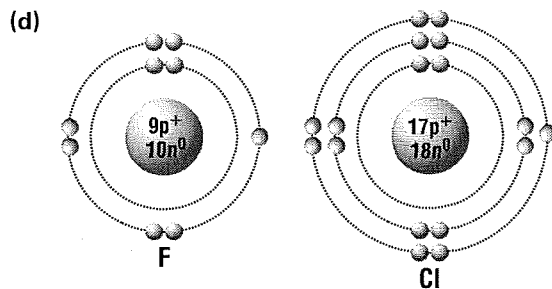


(b)



(c)





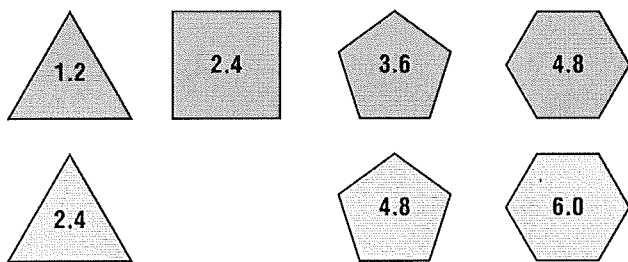
12. For (a), each element has one more orbit than the element above it, and each element has two electrons in its outermost orbit. For (b), each element has one more orbit than the element above it, and each can hold no more electrons in its outermost orbit. For (c), each element has the same number of orbits, and each element has one more electron in the outermost orbit than the element to its left. For (d), chlorine has one more orbit than fluorine, and both have seven electrons in their outermost orbit.
13. (a) Elements in the same family have similar chemical properties and often share or have well defined trends in physical properties.
- (b) Elements in the same period have the same number of orbits in which the electrons reside. Elements become more metallic toward the left in a given period and show other well defined trends.
- (c) The elements in the noble gases are very unreactive and have no room for additional electrons in their outermost orbit.
14. (a) The first orbit holds two electrons at most, and the second and third orbits each hold eight electrons at most.
- (b) There are eighteen elements and the total number of electrons allowed in the first three orbits is also eighteen.
- (c) A new row starts in the periodic table when a new orbit starts filling with electrons.
15. (a) With one electron in the outermost orbit, each alkali metal reacts very vigorously with water and other elements, such as halogens to lose their outer electron and become more stable. The alkali metals are all relatively soft, low-melting point, low density metals.
- (b) The halogens, which have seven outer electrons, are all reactive non-metals, which react to gain one electron, to fill their outer orbit and become more stable. They are all poisonous and some are used as disinfectants or purifying agents.
- (c) Each noble gas cannot accept any more outer electrons. Thus these elements are all very unreactive.
16. Atoms are so small that we will never be able to see inside of them like we might look inside a watch or even inside a cell with a microscope.
17. The discovery of the internal structure of atoms grew out of many discoveries by different scientists. They published and shared their work, which led the way for others to make new discoveries.
18. Answers will vary, but student responses should include how curiosity and questioning lead to a testable prediction or hypothesis that defines an experiment. Analysis of the observations from the experiment leads to a conclusion about the accuracy of a hypothesis.

SOLVE A PROBLEM

19. (a) Solid C was most reactive, and Solid B was least reactive.
- (b) Because they all have a metallic luster and metals get more reactive toward the bottom of a family, Solid B would be highest in the family and Solid C would be lowest.
- (c) Solid X would have a reactivity between those of Solids B and C. Thus X would perhaps not react with water and bubble very slightly in acid.

CREATE AND EVALUATE

20. (a)



This arrangement is based on an increasing number of sides in each row. The blue pieces are in the top row because they have a lower number on them compared to the corresponding yellow shapes.

- (b) Yes, a four-sided piece with 3.6 on it clearly belongs in the yellow row.
- (c) Each row could be extended by adding a seven-sided piece colored like those before it and with a number that is 1.2 greater than the piece immediately to its left. Each column could be extended by adding a piece with the same number of sides as those above it and with a number that is 1.2 greater than the piece immediately above it.
- (d) Mendeleev similarly arranged elements in rows by increasing number (atomic mass in Mendeleev's table) and found that elements in columns had similar properties.

REFLECT ON YOUR LEARNING

21. Answers will vary. Sample answer: Experimentation must always be extensive to test a hypothesis fully. However, creative thinking is necessary to build models of natural phenomena that lead to more creative thinking about how to test the models with experiments. Rutherford, for example, conducted many experiments in investigating atoms and had to use creative thinking to come up with procedures like shooting tiny particles through the atoms in a thin gold foil.

WEB CONNECTIONS

22. Kevlar absorbs moisture, and thus is more environmentally sensitive than carbon or glass fibers, and it is more expensive. According to DuPont, Kevlar does not break down into harmful chemicals in the environment, but neither is it biodegradable and would accumulate when discarded. Answers will vary about its unregulated use, but criminals often can legally obtain bulletproof vests made with Kevlar, a problem for law enforcement.
23. Answers will vary. Student reports should list the points of the theory and cite specific experimental evidence for the refutation of parts or all of the theory. Students may also note parts of the theory that were still consistent with the new evidence.

SUGGESTED ANSWERS

- (a); Choice (a) is correct. The atomic number is the number of protons in the nucleus of an atom. Each atom of a specific element contains the same number of protons. Choice (b) is incorrect. Electrons are located not in the atomic nucleus but in a region surrounding the nucleus. Choice (c) is also incorrect. The number of neutrons varies, even among atoms of the same element. Choice (d) is incorrect because the nucleus of an atom contains only protons and neutrons.
- (d); Choice (d) is correct. Elements that belong to the same family have the same number of outer electrons, which causes these elements to have similar properties. Choice (a) is incorrect because melting point is a characteristic physical property that is different for each element and compound. Choice (b) is also incorrect. Only atoms of the same element have the same number of protons in their nucleus. Choice (c) is incorrect because elements in the same group can exist in different physical states at room temperature.
- (b); Choice (b) is correct. The atomic number of carbon is 6, which means there are six protons in the nucleus of a carbon atom. The mass number of a carbon atom is 12, which means there are six neutrons in the nucleus of a carbon atom ($12 - 6 = 6$). Choice (a) is incorrect. Carbon is the first element in Group 14, but the most common isotope of carbon does not have one neutron in its nucleus. Choice (c) is also incorrect. The average atomic mass of a carbon atom is 12, which is not the same as the number of neutrons in a carbon nucleus. Choice (d) is incorrect. The group number for carbon is 14. This is not the same as the number of neutrons in a carbon nucleus.
- (c); Choice (c) is correct. Water is a compound made of two elements, oxygen and hydrogen. Choices (a), (b), and (d) are all incorrect because sodium, chlorine, and oxygen are elements and they can all be found in the periodic table.
- False. The periodic table developed by Dmitri Mendeleev organized the elements by increasing mass. A true version of the statement would be: In the periodic table we use today, the elements are arranged by increasing atomic number.
- True. Although they are very different in their physical properties, diamonds, pencil graphite, and charcoal are mostly composed of carbon atoms. The different properties of these three substances are caused by the way the carbon atoms are arranged.
- metals, non-metals; Metalloids are located in the periodic table between the metals and non-metals. Metalloids, such as silicon, possess some properties of metals and some properties of non-metals.
- halogens; The elements of Group 17 are also called halogens, which are highly reactive elements.
- Isotopes; Atoms that are isotopes have different mass numbers because they have different numbers of neutrons.
- (a)(v) Atoms are particles that cannot be broken down further and still retain their properties; (b)(i) A proton is a positively charged particle and can be found in the nucleus of an atom; (c)(ii) An element is a pure substance made up of atoms with the same atomic number. The periodic table lists all known elements; (d)(iii) An electron is a negatively charged particle and exists in a region surrounding the nucleus of an atom; (e)(iv) A neutron is a particle with no electrical charge. It can be found in the nucleus of an atom.
- A group is a column of elements on the periodic table. A period is a row of elements on the periodic table. A group of elements has the same number of electrons in their outermost orbits, whereas a period of elements has the same number of electron orbits.
- (a) The particle has a negative charge.
(b) A charged particle cannot be called an atom because an atom is electrically neutral.

13. Sample answer: I would expect fluorine to be the most reactive of the three, based on the following reasoning. Each atom of fluorine, chlorine, and bromine has seven electrons in the outermost orbit, and the atom tries to acquire one extra electron to make a complete set of eight electrons in the outermost orbit. As a result, the atoms of all three elements are very reactive. However, among these three elements, fluorine has the fewest electron orbits, so the outermost electrons are closer to the nucleus. The nucleus of each fluorine atom has the greatest influence on the outermost electrons and is better able to attract the extra electron. For this reason, fluorine atoms are the most reactive.
14. (a) The mass number is the total number of protons and neutrons in the nucleus of an atom. To find the number of protons in an atom, subtract the number of neutrons from the mass number.
 $195 - 117 = 78$ protons
- (b) platinum
15. Sample answer: When Rutherford shot positively charged particles at a thin piece of gold foil, most of the particles passed right through the foil, without changing direction. This behaviour showed that each atom contains mostly empty space, which allowed the particles to pass through unaffected. A small number of the particles did not pass through the foil and bounced back at large angles. This behaviour showed that these positively charged particles were repelled by a small concentration of positively charged particles within gold atoms. This observation led to the concept of a positively charged nucleus within each atom.
16. I would expect an atom of aluminium to have three electron orbits. From its atomic number, I know aluminium has 13 electrons. The first electron orbit can hold two electrons, the next orbit can hold eight electrons, and the third orbit can hold a maximum of eight electrons. The 13 electrons would be distributed as follows: two in the first orbit, eight in the second orbit, and three in the third orbit.
17. (a) Thompson's experiment proved the existence of electrons and Rutherford's experiment proved the existence of protons. Together, these experiments showed that the atom can be broken down into even smaller particles. Dalton's atomic theory was based on the concept that atoms were indivisible.
- (b) No. Parts of the theory are still supported by what we know and believe to be true. The part of the theory that was disproved was revised to support new information.
18. Each electron in an orbit has a definite amount of energy. When an electron gains or loses a specific amount of energy, that electron temporarily moves into a different orbit. The amount of energy of an electron in an atom corresponds to the orbit in which it resides. Therefore, orbits can also be called energy levels.
19. (a) People hold cooking pots by the handle. If the handles were made of a material (such as a metal) that conducts thermal energy, the person holding a hot pan would burn his or her hand.
- (b) A material that does not conduct thermal energy would be best. This material could be plastic or glass, which are poor conductors of thermal energy.
20. (a) Gold and silver are easily shaped to fill a hole in a tooth. Neither metal will react with water or any food someone might eat.
- (b) Gold and silver are very expensive metals. Using them in dental fillings would cost more than using other materials with similar properties.
21. Students should create an advertisement using pictures, drawings, and words to explain why their chosen element is useful. Students should include what they know about the element, such as its appearance, properties, distribution in nature, and uses.
22. Sample answer: I would expect an atom of H-1 to contain zero neutrons. The atomic number of hydrogen is 1, which indicates that there is one proton in a hydrogen atom. The average atomic mass of hydrogen is also 1, which tells me that a hydrogen-1 atom has one proton and zero neutrons.
23. Hydrogen is on the far left side of the periodic table. The elements on the far left are all very reactive, and could be dangerous to use in airships. In fact, hydrogen gas is very flammable. Helium, by contrast, is a noble gas and is on the far right side of the periodic table. The elements on the far right are very stable and do not react readily. Helium does not burn under normal conditions, so it would be much safer to use in airships.