HAPTER 4

Assessment

viewing Content

he smallest particle of an element hat still has the properties of that lement.
emocritus's ideas were not helpul in explaining chemical behavior ecause they lacked experimental upport.
alton would agree with all four tatements because they all fit his tomic theory.
he atoms are separated, joined, nd rearranged.
. A beam of electrons (cathode ays) is deflected by an electric ield toward the positively charged late. **b.** The cathode rays were lways composed of electrons egardless of the metal used in the lectrodes or the gas used in the athode-ray tube.
epel
he mass of the proton and neuron are equal; protons are posiively charged and neutrons are eutral.
toms are neutral: number of proons = number of electrons. Loss of n electron means that the numer of p^+ is greater than the numer of e^-, so the remaining particle s positively charged.
he electrons were stuck in a lump f positive charge.
Ie did not expect alpha particles o be deflected at a large angle.
ositive
rotons and neutrons (Rutherford uspected there was something in he nucleus in addition to protons—but didn't know them as eutrons.)
t has equal numbers of protons and electrons.
he number of protons in the nucleus
a. 15 **b.** 42 **c.** 13 **d.** 48 **e.** 24 **f.** 82
The atomic number is the number of protons. The mass number is the sum of the protons and neutrons.

CHAPTER 4

Assessment

Reviewing Content

4.1 Defining the Atom

34. What is an atom?

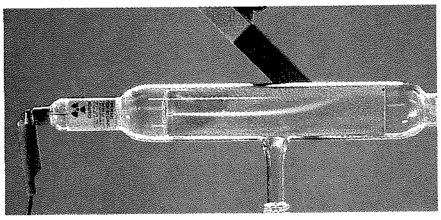
35. What were the limitations of Democritus's ideas about atoms?

36. With which of these statements would John Dalton have agreed in the early 1800s? For each, explain why or why not.
- **a.** Atoms are the smallest particles of matter.
- **b.** The mass of an iron atom is different from the mass of a copper atom.
- **c.** Every atom of silver is identical to every other atom of silver.
- **d.** A compound is composed of atoms of two or more different elements.

37. Use Dalton's atomic theory to describe how atoms interact during a chemical reaction.

4.2 Structure of the Nuclear Atom

38. What experimental evidence did Thomson have for each statement?
- **a.** Electrons have a negative charge.
- **b.** Atoms of all elements contain electrons.



39. Would you expect two electrons to attract or repel each other?

40. How do the charge and mass of a neutron compare to the charge and mass of a proton?

41. Why does it make sense that if an atom loses electrons, it is left with a positive charge?

42. Describe the location of the electrons in Thomson's "plum pudding" model of the atom.

43. How did the results of Rutherford's gold-foil experiment differ from his expectations?

44. What is the charge, positive or negative, of the nucleus of every atom?

45. In the Rutherford atomic model, which subatomic particles are located in the nucleus?

4.3 Distinguishing Among Atoms

46. Why is an atom electrically neutral?

47. What does the atomic number of each atom represent?

48. How many protons are in the nuclei of the following atoms?
- **a.** phosphorus
- **b.** molybdenum
- **c.** aluminum
- **d.** cadmium
- **e.** chromium
- **f.** lead

49. What is the difference between the mass number and the atomic number of an atom?

50. Complete the following table by referring to Figure 4.11 on page 118.

Atomic number	Mass number	Number of protons	Number of neutrons	Symbol of element
9	(a)	(b)	10	(c)
(d)	(e)	14	15	(f)
(g)	47	(h)	25	(i)
(j)	55	25	(k)	(l)

51. Name two ways that isotopes of an element differ.

52. How can there be more than 1000 different atoms when there are only about 100 different elements?

53. What data must you know about the isotopes of an element to calculate the atomic mass of the element?

54. How is an average mass different from a weighted average mass?

55. What is the atomic mass of an element?

56. How are the elements arranged in the modern periodic table?

57. Look up the word *periodic* in the dictionary. Propose a reason for the naming of the periodic table.

50. a. 19 **b.** 9 **c.** F **d.** 14 **e.** 29 **f.** Si **g.** 22 **h.** 22 **i.** Ti **j.** 25 **k.** 30 **l.** Mn

51. mass numbers, atomic masses, number of neutrons, relative abundance

52. because of the existence of isotopes

53. which isotopes exist, their masses, and their natural percent abundance

54. Average atomic mass is the arithmetic mean of the isotopes. Weighted average atomic mass considers both the mass and the relative abundance of the isotopes.

55. The atomic mass is the weighted average of the masses of all the isotopes.

56. according to their atomic numbers

57. Sample answer: The table is set up so that chemical properties of elements recur at regular intervals.

Understanding Concepts

58. Characterize the size of an atom.

59. Compare the size and density of an atom with its nucleus.

60. Imagine you are standing on the top of a boron-11 nucleus. Describe the numbers and kinds of subatomic particles you would see looking down into the nucleus, and those you would see looking out from the nucleus.

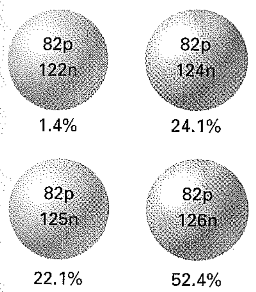
61. What parts of Dalton's atomic theory no longer agree with the current picture of the atom?

62. Millikan measured the quantity of charge carried by an electron. How did he then calculate the mass of an electron?

63. How is the number of electrons in an atom of a given element related to the atomic number of that element?

64. How is the atomic mass of an element calculated from isotope data?

65. The four isotopes of lead are shown below, each with its percent by mass abundance and the composition of its nucleus. Using these data, calculate the approximate atomic mass of lead.



66. Dalton's atomic theory was not correct in every detail. Should this be taken as a criticism of Dalton as a scientist? Explain.

67. Why are atoms considered the basic building blocks of matter even though smaller particles, such as protons and electrons, exist?

68. The following table shows some of the data collected by Rutherford and his colleagues during their gold-foil experiment.

Angle of deflection (degrees)	Number of deflections
5	8,289,000
10	502,570
15	120,570
30	7800
45	1435
60	477
75	211
>105	198

a. What percentage of the alpha particle deflections were 5° or less?

b. What percentage of the deflections were 15° or less?

c. What percentage of the deflections were 60° or greater?

69. Using the data for nitrogen listed in Table 4.3, calculate the weighted average atomic mass of nitrogen. Show your work.

70. What characteristics of cathode rays led Thomson to conclude that the rays consisted of negatively charged particles?

71. If you know the atomic number and mass number of an atom of an element, how can you determine the number of protons, neutrons, and electrons in that atom?

72. What makes isotopes of the same element chemically alike?

73. In the periodic table, what happens to the pattern of properties within a period when you move from one period to the next?

Understanding Concepts

58. very, very tiny—but larger than protons and electrons

59. The nucleus is very small and very dense compared with the atom.

60. 5 protons and 6 neutrons in the nucleus; 5 electrons outside the nucleus

61. All atoms of the same element are not identical (isotopes). The atom is not the smallest particle of matter.

62. He used the quantity of charge value and the charge-to-mass ratio measured by Thomson.

63. They are the same value.

64. The masses of isotopes in a sample of the element are averaged, based on relative abundance. The result is the element's atomic mass.

65. 207 amu

66. No; in general he proposed a valid theory in line with the experimental evidence available to him.

67. Atoms are the smallest particle of an element that retains the properties of that element.

68. **a.** 92.90% **b.** 99.89% **c.** 0.00993%

69. $^{14}_{7}N$: 14.003 amu; 99.63% $^{15}_{7}N$: 15.000 amu; 0.37%
average atomic mass = 14.01 amu

70. They were attracted to a positively charged plate.

71. Atomic number is the same as the number of protons and electrons; mass number minus atomic number equals number of neutrons.

72. Because they have identical numbers of protons, they also have identical numbers of electrons; electrons are the subatomic particles that are responsible for chemical behavior.

73. The pattern repeats.

Critical Thinking

4. **a.** the nucleus of an atom; **b.** very small volume; almost all the mass of the atom; high density; positive charge; **c.** electron
5. Change the metal used as a target and account for differences in deflection patterns.
6. The following are reasonable hypotheses: The space in an individual atom is large relative to the volume of the atom, but very small relative to an object the size of a hand. There are many layers of atoms in a wall or a desk. The space that exists is distributed evenly throughout the solid, similar to the distribution of air pockets in foam insulation.
7. The theory must be modified and then retested.
8. Yes—but answers will vary.
9. In a chemical change, atoms are not created or destroyed; they are rearranged.

Concept Challenge

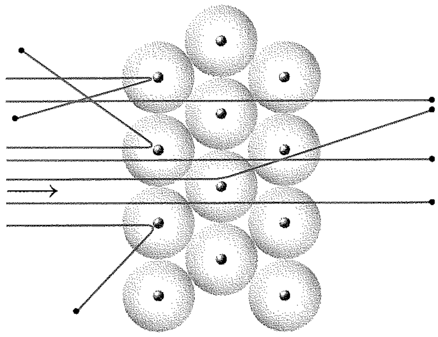
0. Because diamond is more dense than graphite, pressure could be used to "squeeze" the carbon atoms closer together.
1. 92.5%
2. 4×10^{-25} g

Cumulative Review

3. Pure chemistry involves the accumulation of scientific knowledge for its own sake. Applied chemistry is accumulating knowledge to attain a specific goal.
4. Scientific theory attempts to explain why experiments give certain results. Scientific law describes a natural phenomenon but does not explain it.
5. **a.** element **b.** mixture **c.** mixture **d.** mixture
6. 48 g
7. 6.38×10^{7} cm^3
8. 99.5 g

Critical Thinking

74. The diagram below shows gold atoms being bombarded with fast-moving alpha particles.



a. The large yellow spheres represent gold atoms. What do the small gray spheres represent?
b. List at least two characteristics of the small gray spheres.
c. Which subatomic particle cannot be found in the area represented by the gray spheres?

75. How could you modify Rutherford's experimental procedure to determine the relative sizes of different nuclei?

76. Rutherford's atomic theory proposed a dense nucleus surrounded by very small electrons. This implies that atoms are composed mainly of empty space. If all matter is mainly empty space, why is it impossible to walk through walls or pass your hand through your desk?

77. This chapter illustrates the scientific method in action. What happens when new experimental results cannot be explained by the existing theory?

78. Do you think there are more elements left to be discovered? Explain your answer.

79. The law of conservation of mass was introduced in Chapter 2. Use Dalton's atomic theory to explain this law.

Concept Challenge

80. Diamond and graphite are both composed of carbon atoms. The density of diamond is 3.52 g/cm^3. The density of graphite is 2.25 g/cm^3. In 1955, scientists successfully made diamond from graphite. Using the relative densities, imagine what happens at the atomic level when this change occurs. Then suggest how this synthesis may have been accomplished.

81. Lithium has two naturally occurring isotopes. Lithium-6 has an atomic mass of 6.015 amu; lithium-7 has an atomic mass of 7.016 amu. The atomic mass of lithium is 6.941 amu. What is the percentage of naturally occurring lithium-7?

82. When the masses of the particles that make up an atom are added together, the sum is always larger than the actual mass of the atom. The missing mass, called the mass defect, represents the matter converted into energy when the nucleus was formed from its component protons and neutrons. Calculate the mass defect of a chlorine-35 atom by using the data in Table 4.1. The actual mass of a chlorine-35 atom is 5.81×10^{-23} g.

Cumulative Review

83. How does the goal of pure chemistry compare with that of applied chemistry? *(Chapter 1)*

84. How does a scientific law differ from a scientific theory? *(Chapter 1)*

85. Classify each as an element, a compound, or a mixture. *(Chapter 2)*
a. sulfur **b.** salad oil
c. newspaper **d.** orange

86. Oxygen and hydrogen react explosively to form water. In one reaction, 6 g of hydrogen combines with oxygen to form 54 g of water. How much oxygen was used? *(Chapter 2)*

87. An aquarium measures 54.0 cm × 31.10 m × 380.0 cm. How many cubic centimeters of water will this aquarium hold? *(Chapter 3)*

88. What is the mass of 4.42 cm^3 of platinum? The density of platinum is 22.5 g/cm^3. *(Chapter 3)*