

Evaluate

ANSWERS

LESSON 4.1

35. The smallest particle of an element that still has the properties of that element.
36. Democritus's ideas were not helpful in explaining chemical behavior because they lacked experimental support.
37. Dalton would agree with all four statements because they all fit his atomic theory.
38. The atoms are separated, joined, and rearranged.

LESSON 4.2

39. a. A beam of electrons (cathode rays) is deflected by an electric field toward the positively charged plate.
b. The cathode rays were always composed of electrons regardless of the metal used in the electrodes or the gas used in the cathode-ray tube.
40. repel
41. The mass of the proton and neutron are equal; protons are positively charged and neutrons are neutral.
42. Atoms are neutral: number of protons = number of electrons. Loss of an electron means that the number of p^+ is greater than the number of e^- , so the remaining particle is positively charged.
43. The electrons were stuck in a lump of positive charge.
44. He did not expect alpha particles to be deflected at a large angle.
45. positive
46. protons and neutrons (Rutherford suspected there was something in the nucleus in addition to protons—but didn't know them as neutrons.)

LESSON 4.3

47. It has equal numbers of positively-charged protons and negatively-charged electrons.
48. the number of protons in the nucleus
49. a. 15 b. 42 c. 13 d. 48 e. 24 f. 82
50. The atomic number is the number of protons. The mass number is the sum of the protons and neutrons.
51. a. 19 b. 9 c. 14 d. 29 e. 22 f. 22 g. 25 h. 30
52. mass numbers, atomic masses, number of neutrons, relative abundance
53. 6.941



4 Assessment

* Solutions appear in Appendix E

Lesson by Lesson

4.1 Defining the Atom

35. What is an atom?
36. What were the limitations of Democritus's ideas about atoms?
37. With which of these statements would John Dalton have agreed in the early 1800s? For each, explain why or why not.
- Atoms are the smallest particles of matter.
 - The mass of an iron atom is different from the mass of a copper atom.
 - Every atom of silver is identical to every other atom of silver.
 - A compound is composed of atoms of two or more different elements.
38. Use Dalton's atomic theory to describe how atoms interact during a chemical reaction.

4.2 Structure of the Nuclear Atom

39. What experimental evidence did Thomson have for each statement?
- Electrons have a negative charge.
 - Atoms of all elements contain electrons.
- *40. Would you expect two electrons to attract or repel each other?
41. How do the charge and mass of a neutron compare to the charge and mass of a proton?
42. Why does it make sense that if an atom loses electrons, it is left with a positive charge?
43. Describe the location of the electrons in Thomson's "plum-pudding" model of the atom.
- *44. How did the results of Rutherford's gold-foil experiment differ from his expectations?
45. What is the charge, positive or negative, of the nucleus of every atom?
46. In the Rutherford atomic model, which subatomic particles are located in the nucleus?

4.3 Distinguishing Among Atoms

47. Why is an atom electrically neutral?
48. What does the atomic number of each atom represent?

49. How many protons are in the nuclei of the following atoms?
- phosphorus (P)
 - molybdenum (Mo)
 - aluminum (Al)
 - cadmium (Cd)
 - chromium (Cr)
 - lead (Pb)
50. What is the difference between the mass number and the atomic number of an atom?

- *51. Complete the following table.

Atomic number	Mass number	Number of protons	Number of neutrons
9	a. ____	b. ____	10
c. ____	d. ____	14	15
e. ____	47	f. ____	25
g. ____	55	25	h. ____

52. Name two ways that isotopes of an element differ.
- *53. Lithium has two isotopes, lithium-6 (atomic mass = 6.015, relative abundance = 7.5%) and lithium-7 (atomic mass = 7.016, relative abundance = 92.5%). Calculate the atomic mass of lithium.

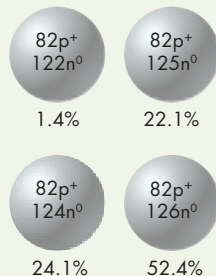
Understand Concepts

- *54. How can there be more than 1000 different atoms when there are only about 100 different elements?
55. What data must you know about the isotopes of an element to calculate the atomic mass of the element?
56. How is an average mass different from a weighted average mass?
57. What is the atomic mass of an element?
58. Characterize the size of an atom.
59. Compare the size and density of an atom with its nucleus.
- *60. You are standing on the top of a boron-11 nucleus. Describe the numbers and kinds of subatomic particles you see looking down into the nucleus, and those you see looking out from the nucleus.

UNDERSTAND CONCEPTS

54. because of the existence of isotopes
55. which isotopes exist, their masses, and their natural percent abundance
56. 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.
57. The atomic mass is the weighted average of the masses of all the isotopes.
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. 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 atomic mass of an element calculated from isotope data?
- *64. 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.



65. Dalton's atomic theory was not correct in every detail. Should this be taken as a criticism of Dalton as a scientist? Explain.
- *66. The following table shows some of the data collected by Rutherford and his colleagues during their gold-foil experiment.

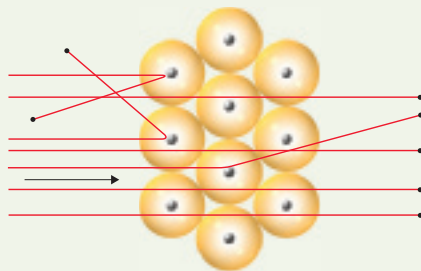
Angle of deflection (degrees)	Number of deflections
5	8,289,000
10	502,570
15	120,570
30	7800
45	1435
60	477
75	211
>105	198

- 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?

- *67. Using the data for nitrogen listed in Table 4.3, calculate the weighted average atomic mass of nitrogen. Show your work.
68. What characteristics of cathode rays led Thomson to conclude that the rays consisted of negatively charged particles?
69. 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?
70. What makes isotopes of the same element chemically alike?
71. If isotopes are chemically alike, but physically different, propose which subatomic particles are responsible for determining an element's chemical reactivity.

Think Critically

72. **Interpret Diagrams** 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?
73. **Evaluate and Revise** How could you modify Rutherford's experimental procedure to determine the relative sizes of different nuclei?

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. The masses of isotopes in a sample of the element are averaged, based on relative abundance. The result is the element's atomic mass.
64. 207 amu
65. No; in general he proposed a valid theory in line with the experimental evidence available to him.
66. a. 92.90% b. 99.89% c. 0.00993%
67. ${}^{14}_7\text{N}$: 14.003 amu; 99.63%
 ${}^{15}_7\text{N}$: 15.000 amu; 0.37%
 average atomic mass = 14.01 amu
68. They were attracted to a positively charged plate.
69. Atomic number is the same as the number of protons and electrons; mass number minus atomic number equals number of neutrons.
70. 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.
71. protons and electrons

THINK CRITICALLY

72. a. the nucleus of an atom;
 b. very small volume; almost all the mass of the atom; high density; positive charge;
 c. electron
73. Change the metal used as a target and account for differences in deflection patterns.