Chemical Skills

Determining Ion Charge from Numbers of Protons and Electrons (Section 4.7)

- From the periodic table or from the alphabetical list of elements, find the atomic number of the element; this number is equal to the number of protons.
- Use the ion charge equation to compute charge.

  Ion charge = #p − #e^-

Examples

EXAMPLE 4.10 **Determining Ion Charge from Numbers of Protons and Electrons**

Determine the charge of a selenium ion with 36 electrons.

Solution:

Selenium is atomic number 34; therefore, it has 34 protons.

Ion charge = 34 − 36 = 2−

Determining the Number of Protons and Electrons in an Ion (Section 4.7)

- From the periodic table or from the alphabetical list of elements, find the atomic number of the element; this number is equal to the number of protons.
- Use the ion charge equation and substitute in the known values.

  Ion charge = #p − #e^-

- Solve the equation for the number of electrons.

EXAMPLE 4.11 **Determining the Number of Protons and Electrons in an Ion**

Find the number of protons and electrons in the O^{2-} ion.

Solution:

The atomic number of O is 8; therefore, it has 8 protons.

Ion charge = #p − #e^-

$2- = 8 - \#e^-$

$\#e^- = 8 + 2 = 10$

The ion has 8 protons and 10 electrons.

Determining Atomic Numbers, Mass Numbers, and Isotope Symbols for an Isotope (Section 4.8)

- From the periodic table or from the alphabetical list of elements, find the atomic number of the element.
- The mass number (A) is equal to the atomic number plus the number of neutrons.
- Write the symbol for the isotope by writing the symbol for the element with the mass number in the upper left corner and the atomic number in the lower left corner.
- The other symbol for the isotope is simply the chemical symbol followed by a hyphen and the mass number.

EXAMPLE 4.12 **Determining Atomic Numbers, Mass Numbers, and Isotope Symbols for an Isotope**

What are the atomic number (Z), mass number (A), and symbols for the iron isotope with 30 neutrons?

Solution:

The atomic number of iron is 26.

A = 26 + 30 = 56

The mass number is 56.

$^{56}_{26}Fe$

Fe-56

Number of Protons and Neutrons from Isotope Symbols (Section 4.8)

- The number of protons is equal to Z (lower left number).
- The number of neutrons is equal to

  A (upper left number) − Z (lower left number).

EXAMPLE 4.13 **Number of Protons and Neutrons from Isotope Symbols**

How many protons and neutrons are in $^{62}_{28}Ni$?

Solution:

28 protons

#n = 62 − 28 = 34 neutrons

Chemical Skills

Calculating Atomic Mass from Percent Natural Abundances and Isotopic Masses (Section 4.9)

- Convert the natural abundances from percent to decimal values by dividing by 100.
- Find the atomic mass by multiplying the fractions of each isotope by their respective masses and adding.
- Round to the correct number of significant figures.
- Check your work.

Examples

EXAMPLE 4.14 Calculating Atomic Mass from Percent Natural Abundances and Isotopic Masses

Copper has two naturally occurring isotopes: Cu-63 with mass 62.9395 amu and a natural abundance of 69.17%, and Cu-65 with mass 64.9278 amu and a natural abundance of 30.83%. Calculate the atomic mass of copper.

Solution:

$$\text{Fraction Cu-63} = \frac{69.17}{100} = 0.6917$$

$$\text{Fraction Cu-65} = \frac{30.83}{100} = 0.3083$$

$$\begin{aligned}\text{Atomic mass} &= (0.6917 \times 62.9395\ \text{amu}) \\ &\quad + (0.3083 \times 64.9278\ \text{amu}) \\ &= 43.5353\ \text{amu} + 20.0107\ \text{amu} \\ &= 63.5460\ \text{amu} \\ &= 63.55\ \text{amu}\end{aligned}$$

KEY TERMS

alkali metals [4.6]
alkaline earth metals [4.6]
anions [4.7]
atomic mass [4.9]
atomic mass unit (amu) [4.4]
atomic number (Z) [4.5]
cations [4.7]
charge [4.4]
chemical symbol [4.5]
electron [4.3]
family (of elements) [4.6]
group (of elements) [4.6]
halogens [4.6]
ions [4.7]
isotopes [4.8]
main-group elements [4.6]
mass number (A) [4.8]
metalloids [4.6]
metals [4.6]
neutrons [4.3]
noble gases [4.6]
nonmetals [4.6]
nuclear radiation [4.9]
nuclear theory of the atom [4.3]
nucleus [4.3]
percent natural abundance [4.8]
periodic law [4.6]
periodic table [4.6]
protons [4.3]
radioactive [4.9]
semiconductor [4.6]
transition elements [4.6]
transition metals [4.6]

EXERCISES

Questions

1. Why is it important to understand atoms?
2. What is an atom?
3. What did Democritus contribute to our modern understanding of matter?
4. What are three main ideas in Dalton's atomic theory?
5. Describe Rutherford's gold foil experiment and the results of that experiment. How did these results contradict the plum pudding model of the atom?
6. What are the main ideas in the nuclear theory of the atom?
7. List the three subatomic particles and their properties.
8. What is electrical charge?
9. Is matter usually charge-neutral? How would matter be different if it were not charge-neutral?
10. What does the atomic number of an element specify?
11. What is a chemical symbol?
12. Give some examples of how elements got their names.
13. What was Dmitri Mendeleev's main contribution to our modern understanding of chemistry?
14. What is the main idea in the periodic law?
15. How is the periodic table organized?
16. What are the properties of metals? Where are metals found on the periodic table?
17. What are the properties of nonmetals? Where are nonmetals found on the periodic table?
18. Where on the periodic table do you find metalloids?
19. What is a family or group of elements?

20. Locate each of the following on the periodic table and give their group number.
    (a) alkali metals
    (b) alkaline earth metals
    (c) halogens
    (d) noble gases
21. What is an ion?
22. What is an anion? What is a cation?
23. Locate each of the following groups on the periodic table and list the charge of the ions they tend to form.
    (a) Group 1A
    (b) Group 2A
    (c) Group 3A
    (d) Group 6A
    (e) Group 7A
24. What are isotopes?
25. What is the percent natural abundance of isotopes?
26. What is the mass number of an isotope?
27. What notations are commonly used to specify isotopes? What do each of the numbers in these symbols mean?
28. What is the atomic mass of an element?

Problems

Atomic and Nuclear Theory

29. Which of the following statements are *inconsistent* with Dalton's atomic theory as it was originally stated? Why?
    (a) All carbon atoms are identical.
    (b) Helium atoms can be split into two hydrogen atoms.
    (c) An oxygen atom combines with 1.5 hydrogen atoms to form water molecules.
    (d) Two oxygen atoms combine with a carbon atom to form carbon dioxide molecules.

30. Which of the following statements are *consistent* with Dalton's atomic theory as it was originally stated? Why?
    (a) Calcium and titanium atoms have the same mass.
    (b) Neon and argon atoms are the same.
    (c) All cobalt atoms are identical.
    (d) Sodium and chlorine atoms combine in a 1:1 ratio to form sodium chloride.

31. Which of the following statements are *inconsistent* with Rutherford's nuclear theory as it was originally stated? Why?
    (a) Helium atoms have two protons in the nucleus and two electrons outside the nucleus.
    (b) Most of the volume of hydrogen atoms is due to the nucleus.
    (c) Aluminum atoms have 13 protons in the nucleus and 22 electrons outside the nucleus.
    (d) The majority of the mass of nitrogen atoms is due to their 7 electrons.

32. Which of the following statements are *consistent* with Rutherford's nuclear theory as it was originally stated? Why?
    (a) Atomic nuclei are small compared to the size of atoms.
    (b) The volume of an atom is mostly empty space.
    (c) Neutral potassium atoms contain more protons than electrons.
    (d) Neutral potassium atoms contain more neutrons than protons.

33. If atoms are mostly empty space, and atoms compose all ordinary matter, then why does solid matter seem to have no space within it?

34. Rutherford's experiment suggested that matter was not as uniform as it appears. What part of his experimental results implied this idea? Explain.

Protons, Neutrons, and Electrons

35. Which of the following statements about electrons are true?
    (a) Electrons repel each other.
    (b) Electrons are attracted to protons.
    (c) Some electrons have a charge of 1− and some have no charge.
    (d) Electrons are much lighter than neutrons.

36. Which of the following statements about electrons are false?
    (a) Most atoms have more electrons than protons.
    (b) Electrons have a charge of 1−.
    (c) If an atom has an equal number of protons and electrons, it will be charge-neutral.
    (d) Electrons experience an attraction to protons.

37. Which of the following statements about protons are true?
(a) Protons have twice the mass of neutrons.
(b) Protons have the same magnitude of charge as electrons but are opposite in sign.
(c) Most atoms have more protons than electrons.
(d) Protons have a charge of 1+.

38. Which of the following statements about protons are false?
(a) Protons have about the same mass as neutrons.
(b) Protons have about the same mass as electrons.
(c) Some atoms don't have any protons.
(d) Protons have the magnitude of charge as neutrons, but opposite in sign.

39. How many electrons would it take to equal the mass of a proton?

40. A helium nucleus has two protons and two neutrons. How many electrons would it take to equal the mass of a helium nucleus?

41. What mass of electrons would be required to just neutralize the charge of 1.0 g of protons?

42. What mass of protons would be required to just neutralize the charge of 1.0 g of electrons?

Elements, Symbols, and Names

43. Find the atomic number (Z) for each of the following elements.
(a) Fr
(b) Kr
(c) Pa
(d) Ge
(e) Al

44. Find the atomic number (Z) for each of the following elements.
(a) Si
(b) W
(c) Ni
(d) Rn
(e) Sr

45. How many protons are in the nucleus of each of the following atoms?
(a) Mn
(b) Ag
(c) Au
(d) Pb
(e) S

46. How many protons are in the nucleus of each of the following atoms?
(a) Y
(b) N
(c) Ne
(d) K
(e) Mo

47. Give the symbol and atomic number corresponding to each of the following elements.
(a) carbon
(b) nitrogen
(c) sodium
(d) potassium
(e) copper

48. Give the symbol and atomic number corresponding to each of the following elements.
(a) boron
(b) neon
(c) silver
(d) mercury
(e) curium

49. Give the name and the atomic number corresponding to the symbol for each of the following elements.
(a) Ar
(b) Sn
(c) Xe
(d) O
(e) Tl

50. Give the name and the atomic number corresponding to the symbol for each of the following elements.
(a) Ti
(b) Li
(c) U
(d) Br
(e) F

51. Fill in the blanks to complete the following table.

Element Name	Element Symbol	Atomic Number
____	Au	79
Tin	____	____
____	As	____
Copper	____	29
____	Fe	____
____	____	80

52. Fill in the blanks to complete the following table.

Element Name	Element Symbol	Atomic Number
____	Al	13
Iodine	____	____
____	Sb	____
Sodium	____	____
____	Rn	86
____	____	82

The Periodic Table

53. Classify each of the following elements as a metal, nonmetal, or metalloid.
(a) Sr
(b) Mg
(c) F
(d) N
(e) As

54. Classify each of the following elements as a metal, nonmetal, or metalloid.
(a) Na
(b) Ge
(c) Si
(d) Br
(e) Ag

55. Which of the following elements would you expect to lose electrons in chemical changes?
(a) potassium
(b) sulfur
(c) fluorine
(d) barium
(e) copper

56. Which of the following elements would you expect to gain electrons in chemical changes?
(a) nitrogen
(b) iodine
(c) tungsten
(d) strontium
(e) gold

57. Which of the following elements are main-group elements?
(a) Te
(b) K
(c) V
(d) Re
(e) Ag

58. Which of the following elements are *not* main-group elements?
(a) Al
(b) Br
(c) Mo
(d) Cs
(e) Pb

59. Which of the following elements are alkaline earth metals?
(a) sodium
(b) aluminum
(c) calcium
(d) barium
(e) lithium

60. Which of the following elements are alkaline earth metals?
(a) rubidium
(b) tungsten
(c) magnesium
(d) cesium
(e) beryllium

61. Which of the following elements are alkali metals?
(a) barium
(b) sodium
(c) gold
(d) tin
(e) rubidiium

62. Which of the following elements are alkali metals?
(a) scandium
(b) iron
(c) potassium
(d) lithium
(e) cobalt

63. Classify each of the following as a halogen, a noble gas, or neither.
(a) Cl
(b) Kr
(c) F
(d) Ga
(e) He

64. Classify each of the following as a halogen, a noble gas, or neither.
(a) Ne
(b) Br
(c) S
(d) Xe
(e) I

65. To what group number does each of the following elements belong?
(a) oxygen
(b) aluminum
(c) silicon
(d) tin
(e) phosphorus

66. To what group number does each of the following elements belong?
(a) germanium
(b) nitrogen
(c) sulfur
(d) carbon
(e) boron

67. Which of the following elements do you expect to be most like sulfur? Why?
(a) nitrogen
(b) oxygen
(c) fluorine
(d) lithium
(e) potassium

68. Which of the following elements do you expect to be most like magnesium? Why?
(a) potassium
(b) silver
(c) bromine
(d) calcium
(e) lead

69. Which of the following pairs of elements do you expect to be most similar? Why?
(a) Si and P
(b) Cl and F
(c) Na and Mg
(d) Mo and Sn
(e) N and Ni

70. Which of the following pairs of elements do you expect to be most similar? Why?
(a) Ti and Ga
(b) N and O
(c) Li and Na
(d) Ar and Br
(e) Ge and Ga

71. Fill in the blanks to complete the following table.

Chemical Symbol	Group Number	Group Name	Metal or Nonmetal
K	____	____	metal
Br	____	halogens	____
Sr	____	____	____
He	8A	____	____
Ar	____	____	____

72. Fill in the blanks to complete the following table.

Chemical Symbol	Group Number	Group Name	Metal or Nonmetal
Cl	7A	____	____
Ca	____	____	metal
Xe	____	____	nonmetal
Na	____	alkali metal	____
F	____	____	____

Ions

73. Complete each of the following.
(a) $Na \longrightarrow Na^+ + $ ____
(b) $O + 2e^- \longrightarrow$ ____
(c) $Ca \longrightarrow Ca^{2+} + $ ____
(d) $Cl + e^- \longrightarrow$ ____

74. Complete each of the following.
(a) $Mg \longrightarrow$ ____ $+ 2e^-$
(b) $Ba \longrightarrow Ba^{2+} + $ ____
(c) $I + e^- \longrightarrow$ ____
(d) $Al \longrightarrow$ ____ $+ 3e^-$

75. Determine the charge of each of the following ions.
(a) oxygen ion with 10 electrons
(b) aluminum ion with 10 electrons
(c) titanium ion with 18 electrons
(d) iodine ion with 54 electrons

76. Determine the charge of each of the following ions.
(a) tungsten ion with 68 electrons
(b) tellurium ion with 54 electrons
(c) nitrogen ion with 10 electrons
(d) barium ion with 54 electrons

77. Determine the number of protons and electrons in each of the following ions.
(a) Na^+
(b) Ba^{2+}
(c) O^{2-}
(d) Co^{3+}

78. Determine the number of protons and electrons in each of the following.
(a) Al^{3+}
(b) S^{2-}
(c) I^-
(d) Ag^+

79. Determine whether each of the following is true or false. If false, correct it.
(a) The Ti^{2+} ion contains 22 protons and 24 electrons.
(b) The I^- ion contains 53 protons and 54 electrons.
(c) The Mg^{2+} ion contains 14 protons and 12 electrons.
(d) The O^{2-} ion contains 8 protons and 10 electrons.

80. Determine whether each of the following is true or false. If false, correct it.
(a) The Fe^+ ion contains 29 protons and 26 electrons.
(b) The Cs^+ ion contains 55 protons and 56 electrons.
(c) The Se^{2-} ion contains 32 protons and 34 electrons.
(d) The Li^+ ion contains 3 protons and 2 electrons.

81. Predict the ion formed by each of the following:
(a) Rb
(b) K
(c) Al
(d) O

82. Predict the ion formed by each of the following:
(a) F
(b) N
(c) Mg
(d) Na

83. Predict how many electrons will most likely be gained or lost by each of the following:
(a) Ga
(b) Li
(c) Br
(d) S

84. Predict how many electrons will most likely be gained or lost by each of the following:
(a) I
(b) Ba
(c) Cs
(d) Se

85. Fill in the blanks to complete the following table.

Symbol	Ion Commonly Formed	Number of Electrons in Ion	Number of Protons in Ion
Te	____	54	____
In	____	____	49
Sr	Sr^{2+}	____	____
____	Mg^{2+}	____	12
Cl	____	____	____

86. Fill in the blanks to complete the following table.

Symbol	Ion Commonly Formed	Number of Electrons in Ion	Number of Protons in Ion
F	____	____	9
____	Be^{2+}	2	____
Br	____	36	____
Al	____	____	13
O	____	____	____

Isotopes

87. What are the atomic number and mass number for each of the following isotopes?
(a) the hydrogen isotope with 1 neutron
(b) the chromium isotope with 27 neutrons
(c) the calcium isotope with 20 neutrons
(d) the tantalum isotope with 108 neutrons

88. How many neutrons are in an atom with the following atomic numbers and mass numbers?
(a) $Z = 28, A = 58$
(b) $Z = 92, A = 238$
(c) $Z = 21, A = 45$
(d) $Z = 18, A = 40$

89. Write isotopic symbols of the form ${}^{A}_{Z}X$ for each of the following isotopes.
(a) the oxygen isotope with 8 neutrons
(b) the fluorine isotope with 10 neutrons
(c) the sodium isotope with 12 neutrons
(d) the aluminum isotope with 14 neutrons

90. Write isotopic symbols of the form X-A (for example, C-13) for each of the following isotopes.
(a) the iodine isotope with 74 neutrons
(b) the phosphorus isotope with 16 neutrons
(c) the uranium isotope with 234 neutrons
(d) the argon isotope with 22 neutrons

91. Write the symbol of each of the following in the form ${}^{A}_{Z}X$.
(a) cobalt-60
(b) neon-22
(c) iodine-131
(d) plutonium-244

92. Write the symbol of each of the following in the form ${}^{A}_{Z}X$.
(a) U-235
(b) V-52
(c) P-32
(d) Xe-144

93. Determine the number of protons and neutrons in each of the following:
(a) ${}^{23}_{11}Na$
(b) ${}^{266}_{88}Ra$
(c) ${}^{208}_{82}Pb$
(d) ${}^{14}_{7}N$

94. Determine the number of protons and neutrons in each of the following:
(a) ${}^{33}_{15}P$
(b) ${}^{40}_{19}K$
(c) ${}^{222}_{86}Rn$
(d) ${}^{99}_{43}Tc$

95. Carbon-14, present within living organisms and substances derived from living organisms, is often used to establish the age of fossils and artifacts. Determine the number of protons and neutrons in a carbon-14 isotope and write its symbol in the form ${}^{A}_{Z}X$.

96. Plutonium-239 is used in nuclear bombs. Determine the number of protons and neutrons in plutonium-239 and write its symbol in the form ${}^{A}_{Z}X$.

Atomic Mass

97. Rubidium has two naturally occurring isotopes: Rb-85 with mass 84.9118 amu and a natural abundance of 72.17%, and Rb-87 with mass 86.9092 amu and a natural abundance of 27.83%. Calculate the atomic mass of rubidium.

98. Silicon has three naturally occurring isotopes: Si-28 with mass 27.9769 amu and a natural abundance of 92.21%, Si-29 with mass 28.9765 amu and a natural abundance of 4.69%, and Si-30 with mass 29.9737 amu and a natural abundance of 3.10%. Calculate the atomic mass of silicon.

99. Bromine has two naturally occurring isotopes (Br-79 and Br-81) and an atomic mass of 79.904 amu.
(a) If the natural abundance of Br-79 is 50.69%, what is the natural abundance of Br-81?
(b) If the mass of Br-81 is 80.9163 amu, what is the mass of Br-79?

100. Silver has two naturally occurring isotopes (Ag-107 and Ag-109).
(a) Use the periodic table to find the atomic mass of silver.
(b) If the natural abundance of Ag-107 is 51.84%, what is the natural abundance of Ag-109?
(c) If the mass of Ag-107 is 106.905 amu, what is the mass of Ag-109?

101. An element has two naturally occurring isotopes. Isotope 1 has a mass of 120.9038 amu and a relative abundance of 57.4%, and isotope 2 has a mass of 122.9042 amu and a relative abundance of 42.6%. Find the atomic mass of this element and, by comparison to the periodic table, identify it.

102. Copper has two naturally occurring isotopes. Cu-63 has a mass of 62.939 amu and relative abundance of 69.17%. Use the atomic weight of copper to determine the mass of the other copper isotope.

Cumulative Problems

103. Electrical charge is sometimes reported in coulombs (C). On this scale, 1 electron has a charge of -1.6×10^{-19} C. Suppose your body acquires -125 mC (millicoulombs) of charge on a dry day. How many excess electrons has it acquired? (*Hint:* Use the charge of an electron in coulombs as a conversion factor between charge and electrons.)

104. How many excess protons are in a positively charged object with a charge of $+398$ mC (millicoulombs)? The charge of 1 proton is $+1.6 \times 10^{-19}$ C.

105. The hydrogen atom contains 1 proton and 1 electron. The radius of the proton is approximately 1.0 fm (femtometers), and the radius of the hydrogen atom is approximately 53 pm (picometers). Calculate the volume of the nucleus and the volume of the atom for hydrogen. What percentage of the hydrogen atom's volume is occupied by the nucleus?

106. Carbon-12 contains 6 protons and 6 neutrons. The radius of the nucleus is approximately 2.7 fm, and the radius of the atom is approximately 70 pm. Calculate the volume of the nucleus and the volume of the atom. What percentage of the carbon atom's volume is occupied by the nucleus?

107. Prepare a table such as Table 4.2 for the four different isotopes of Sr that have the following natural abundances and masses.

Sr-84	0.56%	83.9134 amu
Sr-86	9.86%	85.9093 amu
Sr-87	7.00%	86.9089 amu
Sr-88	82.58%	87.9056 amu

Use your table and the preceding atomic masses to calculate the atomic mass of strontium.

108. Determine the number of protons and neutrons in each of the following isotopes of chromium and use the following natural abundances and masses to calculate its atomic mass.

Cr-50	4.345%	49.9460 amu
Cr-52	83.79%	51.9405 amu
Cr-53	9.50%	52.9407 amu
Cr-54	2.365%	53.9389 amu

109. Fill in the blanks to complete the following table.

Symbol	Z	A	Number of Protons	Number of Electrons	Number of Neutrons	Charge
Zn^{+}	____	____	____	____	34	1+
____	25	55	____	22	____	____
____	____	____	15	15	16	____
O^{2-}	____	16	____	____	____	2−
____	____	____	16	18	18	____

110. Fill in the blanks to complete the following table.

Symbol	Z	A	Number of Protons	Number of Electrons	Number of Neutrons	Charge
Mg^{2+}	____	25	____	____	13	2+
____	22	48	____	18	____	____
____	16	____	____	____	16	2−
Ga^{3+}	____	71	____	____	____	____
____	____	____	82	80	125	____

111. Europium has two naturally occurring isotopes: Eu-151 with a mass of 150.9198 amu and a natural abundance of 47.8%, and Eu-153. Use the atomic mass of europium to find the mass and natural abundance of Eu-153.

112. Rhenium has two naturally occurring isotopes: Re-185 with a natural abundance of 37.40%, and Re-187 with a natural abundance of 62.60%. The sum of the masses of the two isotopes is 371.9087 amu. Find the masses of the individual isotopes.

113. Chapter 1 describes the difference between observations, laws, and theories. Give two examples of theories from this chapter and explain why they are theories.

114. Chapter 1 describes the difference between observations, laws, and theories. Give one example of a law from this chapter and explain why it is a law.

115. The atomic mass of fluorine is 19.00 amu, and all fluorine atoms in a naturally occurring sample of fluorine have this mass. The atomic mass of chlorine is 35.45 amu, but no chlorine atoms in a naturally occurring sample of chlorine have this mass. Explain the difference.

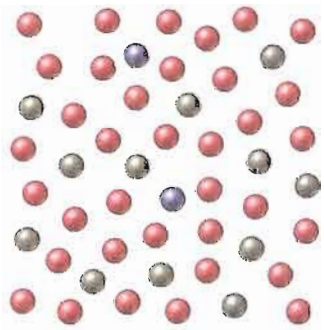
116. The atomic mass germanium is 72.61 amu. Is it likely that any individual germanium atoms have a mass of 72.61 amu?

117. Copper has only two naturally occurring isotopes, Cu-63 and Cu-65. The mass of Cu-63 is 62.9396 amu, and the mass of Cu-65 is 64.9278 amu. Use the atomic mass of copper to determine the relative abundance of each isotope in a naturally occurring sample.

118. Gallium has only two naturally occurring isotopes, Ga-69 and Ga-71. The mass of Ga-69 is 68.9256 amu, and the mass of Ga-71 is 70.9247 amu. Use the atomic mass of gallium to determine the relative abundance of each isotope in a naturally occurring sample.

Highlight Problems

119. The figure is a representation of fifty atoms of a fictitious element with the symbol Nt and atomic number 120. Nt has three isotopes represented by the following colors: Nt-304 (red), Nt-305 (blue), and Nt-306 (green).



(a) Assuming that the figure is statistically representative of naturally occurring Nt, what is the percent natural abundance of each Nt isotope?

(b) Use the following masses of each isotope to calculate the atomic mass of Nt. Then draw a box for the element similar to the boxes for each element shown in the periodic table in the inside front cover of this book. Make sure your box includes the atomic number, symbol, and atomic mass. (Assume that the percentages from part (a) are good to four significant figures.)

Nt-304	303.956 amu
Nt-305	304.962 amu
Nt-306	305.978 amu

120. Neutron stars are believed to be composed of solid nuclear matter, primarily neutrons.

(a) If the radius of a neutron is 1.0×10^{-13} cm, calculate the density of a neutron in g/cm^3. (volume of a sphere $= \frac{4}{3}\pi r^3$)

(b) Assuming that a neutron star has the same density as a neutron, calculate the mass in kilograms of a small piece of a neutron star the size of a spherical pebble with a radius of 0.10 mm.

Answers to Skillbuilder Exercises

Skillbuilder 4.1 (a) sodium, 11
(b) nickel, 28
(c) phosphorus, 15
(d) tantalum, 73

Skillbuilder 4.2 (a) nonmetal
(b) nonmetal
(c) metal
(d) metalloid

Skillbuilder 4.3 (a) alkali metal, group 1A
(b) Group 3A
(c) halogen, group 7A
(d) noble gas, group 8A

Skillbuilder 4.4 (a) 2+
(b) 1−
(c) 3−

Skillbuilder 4.5 16 protons, 18 electrons

Skillbuilder 4.6 K^+ and S^{2-}

Skillbuilder 4.7 Z = 17, A = 35, Cl-35, and $^{35}_{17}Cl$

Skillbuilder 4.8 19 protons, 20 neutrons

Skillbuilder 4.9 24.31 amu

Answers to Conceptual Checkpoints

4.1 (c) The mass in amu is approximately equal to the number of protons plus the number of neutrons. In order to be charge-neutral, the number of protons must equal the number of electrons.

4.2 (b) All of the metalloids are main-group elements (see Figures 4.12 and 4.13).

4.3 (a) Both of these ions have 10 electrons.

4.4 (b) This atom must have (27 − 14) = 13 protons; the element with an atomic number of 13 is Al.

4.5 The isotopes C-12 and C-13 would not look different in this representation of atoms because the only difference between the two isotopes is that C-13 has an extra neutron in the nucleus. The illustration represents the whole atom and does not attempt to illustrate its nucleus. Since the nucleus of an atom is miniscule compared to the size of the atom itself, the extra neutron would not affect the size of the atom.