

Chapter 02: Atoms Molecules and Ions

A periodic table is required to work many of the problems in this chapter.

- In a cathode ray tube
 - electrons pass from the anode to the cathode.
 - electrons pass from the cathode to the anode.
 - protons pass from the anode to the cathode.
 - protons pass from the cathode to the anode.Ans: B Category: Medium Section: 2.2
- The elements in a column of the periodic table are known as
 - metalloids.
 - a period.
 - noble gases.
 - a group.
 - nonmetals.Ans: D Category: Easy Section: 2.4
- Which of the following elements is most likely to be a good conductor of electricity?
 - N
 - S
 - He
 - Cl
 - FeAns: E Category: Easy Section: 2.4
- An *anion* is defined as
 - a charged atom or group of atoms with a net negative charge.
 - a stable atom.
 - a group of stable atoms.
 - an atom or group of atoms with a net positive charge.Ans: A Category: Easy Section: 2.5
- The scientist who determined the magnitude of the electric charge of the electron was
 - John Dalton.
 - Robert Millikan.
 - J. J. Thomson.
 - Henry Moseley.
 - R. Chang.Ans: B Category: Easy Section: 2.2
- When J. J. Thomson discovered the electron, what physical property of the electron did he measure?
 - its charge, e
 - its charge-to-mass ratio, e/m
 - its temperature, T
 - its mass, m
 - its atomic number, ZAns: B Category: Easy Section: 2.2
- Which of the following scientists developed the nuclear model of the atom?
 - John Dalton
 - Robert Millikan
 - J. J. Thomson
 - Henry Moseley
 - Ernest RutherfordAns: E Category: Easy Section: 2.2

8. Rutherford's experiment with alpha particle scattering by gold foil established that
- A) protons are not evenly distributed throughout an atom.
 - B) electrons have a negative charge.
 - C) electrons have a positive charge.
 - D) atoms are made of protons, neutrons, and electrons.
 - E) protons are 1840 times heavier than electrons.

Ans: A Category: Medium Section: 2.2

9. Atoms of the same element with different mass numbers are called
- A) ions. B) neutrons. C) allotropes. D) chemical families. E) isotopes.

Ans: E Category: Easy Section: 2.3

10. How many neutrons are there in an atom of uranium whose mass number is 235?

A) 92 B) 143 C) 235 D) 238 E) 327

Ans: B Category: Easy Section: 2.3

11. How many protons are there in an atom of uranium whose mass number is 235?

A) 92 B) 143 C) 235 D) 238 E) 327

Ans: A Category: Easy Section: 2.3

12. An atom of the isotope chlorine-37 consists of how many protons, neutrons, and electrons? (p = proton, n = neutron, e = electron)

A) 17 p, 18.45 n, 17 e

D) 17 p, 37 n, 17 e

B) 17 p, 20 n, 7 e

E) 20 p, 17 n, 20 e

C) 17 p, 20 n, 17 e

Ans: C Category: Medium Section: 2.3

13. Give the number of protons (p), electrons (e), and neutrons (n) in one atom of nickel-62.

A) 28 p, 28 e, 28 n

D) 62 p, 28 e, 28 n

B) 28 p, 28 e, 34 n

E) 62 p, 62 e, 28 n

C) 28 p, 28 e, 62 n

Ans: B Category: Medium Section: 2.3

14. Which one of the following is an ion?

A) B^{3+} B) NaCl C) He D) ^{14}C E) none of the above

Ans: A Category: Easy Section: 2.5

15. Which one of the following elements is most likely to form a 2+ ion?

A) beryllium B) carbon C) fluorine D) oxygen E) sodium

Ans: A Category: Medium Section: 2.5

16. Which one of the following elements is most likely to form a 2- ion?

A) scandium B) selenium C) silicon D) strontium E) iodine

Ans: B Category: Medium Section: 2.5

17. Two isotopes of an element differ in their
 A) symbol. D) number of protons.
 B) atomic number. E) number of electrons.
 C) atomic mass.
 Ans: C Category: Easy Section: 2.3
18. A magnesium ion, Mg^{2+} , has
 A) 12 protons and 13 electrons. D) 24 protons and 22 electrons.
 B) 24 protons and 26 electrons. E) 12 protons and 14 electrons.
 C) 12 protons and 10 electrons.
 Ans: C Category: Medium Section: 2.5
19. An aluminum ion, Al^{3+} , has:
 A) 13 protons and 13 electrons D) 13 protons and 10 electrons
 B) 27 protons and 24 electrons E) 10 protons and 13 electrons
 C) 16 protons and 13 electrons
 Ans: D Category: Medium Section: 2.5
20. An oxide ion, O^{2-} , has:
 A) 8 protons and 10 electrons D) 8 protons and 7 electrons
 B) 10 protons and 8 electrons E) 10 protons and 7 electrons
 C) 8 protons and 9 electrons
 Ans: A Category: Medium Section: 2.5
21. A phosphide ion has:
 A) 10 protons and 13 electrons D) 15 protons and 18 electrons
 B) 12 protons and 15 electrons E) 18 protons and 21 electrons
 C) 15 protons and 15 electrons
 Ans: D Category: Medium Section: 2.5
22. An iron(II) ion has:
 A) 24 electrons and a charge of 2+ D) 28 electrons and a charge of 2+
 B) 24 electrons and a charge of 2- E) 28 electrons and a charge of 2-
 C) 26 electrons and a charge of 2+
 Ans: A Category: Medium Section: 2.5
23. How many protons and electrons are present in one Br^- ion?
 A) 35 p, 35 e D) 35 p, 36 e
 B) 80 p, 81 e E) 80 p, 34 e
 C) 35 p, 34 e
 Ans: D Category: Medium Section: 2.5

24. Which of the following pairs of elements would be most likely to form an ionic compound?
A) P and Br B) Cu and K C) C and O D) O and Zn E) Al and Rb
Ans: D Category: Medium Section: 2.6
25. Which pair of elements would be most likely to form an ionic compound?
A) P and Br B) Zn and K C) F and Al D) C and S E) Al and Rb
Ans: C Category: Medium Section: 2.6
26. Given that the ion ClO_3^- is named chlorate, what is the ion ClO_4^- named?
A) chloride B) chlorite C) hypochlorite D) perchlorite E) perchlorate
Ans: E Category: Medium Section: 2.7
27. What is the formula for the ionic compound formed by calcium ions and nitrate ions?
A) Ca_3N_2 B) $\text{Ca}(\text{NO}_3)_2$ C) Ca_2NO_3 D) Ca_2NO_2 E) CaNO_3
Ans: B Category: Medium Section: 2.7
28. What is the formula for the ionic compound formed by calcium and selenium?
A) CaSe B) Ca_2Se C) CaSe_2 D) Ca_3Se E) CaSe_3
Ans: A Category: Medium Section: 2.6
29. What is the formula for the ionic compound formed by magnesium and iodine?
A) MgI B) Mg_2I C) MgI_2 D) MgI_3 E) Mg_3I
Ans: C Category: Medium Section: 2.6
30. What is the formula for the binary compound formed by potassium and nitrogen?
A) KN B) K_2N C) NK_2 D) K_3N E) NK_3
Ans: D Category: Medium Section: 2.6
31. Predict the formula for the binary compound formed between barium and phosphorus.
A) BaP B) Ba_2P C) BaP_2 D) Ba_2P_3 E) Ba_3P_2
Ans: E Category: Medium Section: 2.6
32. Name the binary compound formed between barium and phosphorus.
A) barium phosphorus D) barium diphosphate
B) barium phosphide E) barium triphosphide
C) barium phosphate
Ans: B Category: Medium Section: 2.7
33. Which is the correct formula for copper(II) phosphate?
A) Cu_2PO_4 B) $\text{Cu}_3(\text{PO}_4)_2$ C) Cu_2PO_3 D) $\text{Cu}(\text{PO}_4)_2$ E) $\text{Cu}(\text{PO}_3)_2$
Ans: B Category: Medium Section: 2.7

34. The chemical name for ClO_3^- is chlorate ion. Therefore, the name of HClO_3 is
 A) hydrochloric acid. D) chlorous acid.
 B) chloroform. E) chloric acid.
 C) hydrogen trioxochloride.
 Ans: E Category: Medium Section: 2.7
35. The chemical name for ClO_2^- is chlorite ion. Therefore, the name of HClO_2 is
 A) hydrochloric acid. D) chlorous acid.
 B) chloroform. E) chloric acid.
 C) hydrogen dioxochloride.
 Ans: D Category: Medium Section: 2.7
36. Which of the following is the formula for hydrobromic acid?
 A) KBr B) HBr C) HBrO D) HBrO_2 E) HBrO_3
 Ans: B Category: Medium Section: 2.7
37. The formula for calcium phosphate is
 A) CaPO_4 . B) $\text{Ca}_3(\text{PO}_4)_2$. C) $\text{Ca}_2(\text{PO}_4)_3$. D) Ca_3P_2 . E) $\text{Ca}_3(\text{PO}_3)_2$.
 Ans: B Category: Medium Section: 2.7
38. The formula for magnesium sulfate is
 A) MnS . B) MgS . C) MnSO_3 . D) MgSO_4 .
 Ans: D Category: Medium Section: 2.7
39. The formula for sodium sulfide is
 A) NaS . B) K_2S . C) NaS_2 . D) Na_2S . E) SeS .
 Ans: D Category: Medium Section: 2.7
40. The correct name for NH_4NO_3 is
 A) ammonium nitrate. D) hydrogen nitrogen oxide.
 B) ammonium nitrogen trioxide. E) hydrogen nitrate.
 C) ammonia nitrogen oxide.
 Ans: A Category: Medium Section: 2.7
41. The correct name for $\text{Ba}(\text{OH})_2$ is
 A) barium hydrogen oxide. D) beryllium hydroxide.
 B) boron hydroxide. E) barium hydroxide.
 C) barium hydrate.
 Ans: E Category: Medium Section: 2.7
42. The correct name for KHCO_3 is
 A) calcium bicarbonate. D) calcium hydrogen carbon trioxide.
 B) calcium carbonate. E) potassium hydrogen carbonate.
 C) potassium carbonate.
 Ans: E Category: Medium Section: 2.7

43. The correct name for $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ is
 A) copper sulfate acid. D) copper(II) sulfate pentahydrate.
 B) copper sulfate pentahydrate. E) copper(V) sulfate hydrate.
 C) copper(II) sulfate acid.
 Ans: D Category: Medium Section: 2.7
44. Give the formula for cobalt(II) chlorate dihydrate:
 A) $\text{CoCl}_2 \cdot 2\text{H}_2\text{O}$ D) $\text{Co}(\text{ClO}_3)_2 \cdot 2\text{H}_2\text{O}$
 B) $\text{CoClO}_3(\text{H}_2\text{O})_2$ E) $\text{Co}_2(\text{ClO}_3)_3 \cdot 2\text{H}_2\text{O}$
 C) $\text{Co}(\text{ClO}_3)_2(\text{H}_2\text{O})_2$
 Ans: D Category: Medium Section: 2.7
45. The Stock system name for Mn_2O_7 is
 A) dimanganese heptaoxide. D) manganese(II) oxide.
 B) magnesium oxide. E) manganese(III) oxide.
 C) manganese(VII) oxide.
 Ans: C Category: Medium Section: 2.7
46. The Stock system name for As_2S_5 is
 A) arsenic(V) sulfide. D) arsenic(V) sulfate.
 B) diarsenic pentasulfide. E) diarsenic sulfate.
 C) arsenic(III) sulfide.
 Ans: A Category: Medium Section: 2.7
47. Consistent with vanadium being a transition metal, the name for VSO_4 should be
 A) vanadium sulfide. D) vanadium (II) sulfate.
 B) vanadium (I) sulfite. E) vanadium sulfur tetraoxide.
 C) vanadium (I) sulfate.
 Ans: D Category: Medium Section: 2.7
48. Which is the correct formula for lead(IV) chloride?
 A) Pb_4Cl B) PbCl_2 C) PbCl_3 D) PbCl_4 E) Pb_2Cl_4
 Ans: D Category: Medium Section: 2.7
49. The chemical formula for iron(II) nitrate is:
 A) $\text{Fe}_2(\text{NO}_3)_3$ B) $\text{Ir}(\text{NO}_2)_2$ C) Fe_2N_3 D) $\text{Fe}(\text{NO}_3)_2$ E) $\text{Fe}(\text{NO}_2)_2$
 Ans: D Category: Medium Section: 2.7
50. The Stock system name for $\text{Co}_2(\text{SO}_3)_3$ is:
 A) cobalt sulfate D) cobalt(III) sulfite
 B) cobalt(II) sulfite E) cobalt(III) sulfate
 C) cobalt(II) sulfate
 Ans: D Category: Medium Section: 2.7

60. Which of the following elements is chemically similar to potassium?
A) calcium B) arsenic C) phosphorus D) cerium E) cesium
Ans: E Category: Medium Section: 2.4
61. Describe the contributions of Marie Curie.
Ans: (note that answers will vary) Marie Curie discovered two new elements, and is one of three people to win two Nobel Prizes. She also suggested the term “radioactivity” to describe the spontaneous emission of particles and/or radiation.
Category: Easy Section: 2.1
62. What is the law of conservation of mass?
Ans: Matter can be neither created nor destroyed.
Category: Easy Section: 2.1
63. What are the three subatomic particles that are important in chemistry?
Ans: electrons, protons, and neutrons
Category: Easy Section: 2.2
64. What are the three types of radiation produced by the decay of substances like uranium?
Ans: Alpha, beta, and gamma radiation
Category: Easy Section: 2.1
65. How many electrons, protons, and neutrons does an iron-55 atom have?
Ans: 26 electrons, 26 protons, and 29 neutrons
Category: Medium Section: 2.3
66. Define the term *molecule*.
Ans: A molecule is an aggregate of at least two atoms in a definite arrangement held together by chemical forces.
Category: Easy Section: 2.5
67. What are the seven elements that naturally occur as diatomic molecules?
Ans: Hydrogen, nitrogen, oxygen, fluorine, chlorine, bromine, iodine
Category: Medium Section: 2.5
68. Define *ion*.
Ans: An ion is an atom or group of atoms that has a net positive or negative charge.
Category: Easy Section: 2.5

73. Use the periodic table above to show where the metalloids are located.
Ans: Group 2A
Category: Medium Section: 2.4
74. Use the periodic table above to show where the nonmetals are located.
Ans: Group 2A
Category: Easy Section: 2.4
75. Use the periodic table above to show where the halogen elements are located.
Ans: Group 7A
Category: Easy Section: 2.4
76. Use the periodic table above to show where the noble gases are located.
Ans: Group 8A
Category: Easy Section: 2.4
77. How many protons are there in one atom of nickel?
Ans: 28
Category: Medium Section: 2.3
78. How many protons are there in one atom of magnesium?
Ans: 12
Category: Medium Section: 2.3
79. How many protons are there in one atom of xenon?
Ans: 54
Category: Medium Section: 2.3
80. How many protons are there in one atom of uranium?
Ans: 92
Category: Medium Section: 2.3
81. A molecule of antifreeze, ethylene glycol, has the formula $C_2H_4(OH)_2$. How many atoms are there in one molecule of antifreeze?
Ans: 10
Category: Easy Section: 2.5
82. What is the total number of atomic particles (protons, neutrons, and electrons) in an atom of 3H ?
Ans: 4
Category: Medium Section: 2.3

83. What is the total number of atomic particles (protons, neutrons, and electrons) in an atom of ^{40}Ca ?
Ans: 60
Category: Medium Section: 2.3
84. What is the total number of atomic particles (protons, neutrons, and electrons) in an atom of ^{18}F ?
Ans: 27
Category: Medium Section: 2.3
85. How many atoms are in one molecule of CaCl_2 ?
Ans: 3
Category: Easy Section: 2.5
86. How many atoms are in one molecule of $\text{C}_6\text{H}_{12}\text{O}_6$?
Ans: 24
Category: Easy Section: 2.5
87. Give the formula for potassium oxide.
Ans: K_2O
Category: Medium Section: 2.7
88. Give the formula for calcium chloride.
Ans: CaCl_2
Category: Medium Section: 2.7
89. Give the formula for carbon disulfide.
Ans: CS_2
Category: Medium Section: 2.7
90. Give the formula for lithium hydroxide.
Ans: LiOH
Category: Medium Section: 2.7
91. Give the formula for nickel(II) sulfate.
Ans: NiSO_4
Category: Medium Section: 2.7
92. Name the following binary compound: FeS .
Ans: iron(II) sulfide
Category: Medium Section: 2.7
93. Name the following binary compound: NaH .
Ans: sodium hydride
Category: Medium Section: 2.7

94. Name the following binary compound: MnCl_2 .
Ans: manganese(II) chloride
Category: Medium Section: 2.7
95. Name the following binary compound: AgCl .
Ans: silver chloride; may accept silver(I) chloride.
Category: Medium Section: 2.7
96. Name the following binary compound: Fe_2O_3 .
Ans: iron(III) oxide (or ferric oxide)
Category: Medium Section: 2.7
97. Name the following ternary compound: CuCO_3 .
Ans: copper(II) carbonate
Category: Medium Section: 2.7
98. Name the following ternary compound: FeSO_4 .
Ans: iron(II) sulfate
Category: Medium Section: 2.7
99. Name the following ternary compound: Na_3PO_4 .
Ans: sodium phosphate
Category: Medium Section: 2.7
100. Name the following ternary compound: $\text{Al}(\text{NO}_3)_3$.
Ans: aluminum nitrate
Category: Medium Section: 2.7
101. Name the following compound: Cl_2O_7 .
Ans: dichlorine heptoxide, or dichlorine heptoxide
Category: Medium Section: 2.7
102. Name the straight chain hydrocarbon that contains eight carbon atoms.
Ans: octane
Category: Medium Section: 2.8

103. The table below describes four atoms.

	Atom A	Atom B	Atom C	Atom D
Number of protons	79	80	80	79
Number of neutrons	118	120	118	120
Number of electrons	79	80	80	79

Which atoms represent the same element?

Ans: Atoms A and D represent the same element, and atoms B and C represent the same element.

Category: Medium Section: 2.3

104. Consider a neutral atom of the following isotope of sulfur:



How many electrons, protons, and neutrons does the atom contain?

Ans: 16 electrons, 16 protons, and 18 neutrons

Category: Medium Section: 2.3

105. How many electrons, protons, and neutrons are in a neutral atom of the following isotope of calcium?



Ans: 20 electrons, 20 protons, and 24 neutrons

Category: Medium Section: 2.3

106. How many electrons, protons, and neutrons are in a neutral atom of the following isotope of krypton?



Ans: 36 electrons, 36 protons, and 48 neutrons

Category: Medium Section: 2.3

107. How many electrons, protons, and neutrons are in a neutral atom of the following isotope of gadolinium?



Ans: 64 electrons, 64 protons, and 96 neutrons

Category: Medium Section: 2.3

108. Write the names and symbols of two metals and two nonmetals. Identify which are the metals and which are the nonmetals.

Ans: (Answers will vary.) Metals: iron, Fe; sodium, Na; etc. Nonmetals: chlorine, Cl; nitrogen, N; etc.

Category: Easy Section: 2.4

109. Predict the formula for the binary compound formed between potassium and sulfur.
Ans: K_2S
Category: Medium Section: 2.6
110. Predict the formula for the binary compound formed between aluminum and fluorine.
Ans: AlF_3
Category: Medium Section: 2.6
111. Give the formula of magnesium nitrate.
Ans: $Mg(NO_3)_2$
Category: Medium Section: 2.7
112. Give the formula of calcium phosphate.
Ans: $Ca_3(PO_4)_2$
Category: Medium Section: 2.7
113. Give the formula of iron(II) phosphate.
Ans: $Fe_3(PO_4)_2$
Category: Medium Section: 2.7
114. Give the formula of copper(II) bromide.
Ans: $CuBr_2$
Category: Medium Section: 2.7
115. Give the formula of ammonium sulfate.
Ans: $(NH_4)_2SO_4$
Category: Medium Section: 2.7
116. Give the formula of hydrochloric acid.
Ans: HCl
Category: Medium Section: 2.7
117. Give the formula of carbonic acid.
Ans: H_2CO_3
Category: Medium Section: 2.7
118. Give the formula of nitric acid.
Ans: HNO_3
Category: Medium Section: 2.7
119. Give the formula of sulfuric acid.
Ans: H_2SO_4
Category: Medium Section: 2.7

120. Write the formula for the acid formed from the fluoride anion, and then name the acid.
Ans: HF, hydrofluoric acid
Category: Medium Section: 2.7
121. Write the formula for the acid formed from the nitrite anion, and then name the acid.
Ans: HNO₂, nitrous acid
Category: Medium Section: 2.7
122. Write the formula for the acid formed from the permanganate anion, and then name the acid.
Ans: HMnO₄, permanganic acid
Category: Medium Section: 2.7
123. Write the formula for the acid formed from the hydrogen sulfate anion, and then name the acid.
Ans: H₂SO₄, sulfuric acid
Category: Difficult Section: 2.7
124. The elements known as the halogens are useful as disinfectants. Name two halogens.
Ans: (two of these) fluorine, chlorine, bromine, iodine
Category: Medium Section: 2.4
125. Define *allotrope*.
Ans: An allotrope is one of the two or more distinct forms of an element.
Category: Easy Section: 2.6
126. What are *isotopes*?
Ans: Atoms of the same element that have the same atomic number but different mass numbers.
Category: Easy Section: 2.3
127. Name the following compound: NaNO₂.
Ans: sodium nitrite
Category: Medium Section: 2.7
128. Name the following compound: KCl.
Ans: potassium chloride
Category: Medium Section: 2.7
129. Name the following compound: Mg(NO₃)₂.
Ans: magnesium nitrate
Category: Medium Section: 2.7

130. Write the formula of ammonium chlorate.
Ans: NH_4ClO_3
Category: Medium Section: 2.7
131. Write the formula of lead(II) chloride.
Ans: PbCl_2
Category: Medium Section: 2.7
132. Write the formula of calcium carbonate.
Ans: CaCO_3
Category: Medium Section: 2.7
133. The formula for isopropyl alcohol is sometimes written as $(\text{CH}_3)_2\text{CHOH}$ to better indicate how the atoms are connected. How many hydrogen atoms would be contained in 3 dozen isopropyl alcohol molecules?
Ans: 288
Category: Medium Section: 2.5
134. Almost all the mass of an atom is concentrated in the nucleus.
Ans: True Category: Easy
135. Marie Curie suggested the name “radioactivity” to describe the spontaneous emission of particles and/or radiation.
Ans: True Category: Easy
136. Using a cathode ray tube, J. J. Thomson determined the magnitude of the electric charge on the electron.
Ans: False Category: Easy
137. When a beam of alpha particles passes between two electrically charged plates, the beam is deflected toward the positive plate.
Ans: False Category: Medium
138. The proton is about 1840 times heavier than the electron.
Ans: True Category: Easy
139. The atomic number is equal to the number of protons in the nucleus of each atom of an element.
Ans: True Category: Easy
140. The number of neutrons in all atoms of an element is the same.
Ans: False Category: Medium

141. An empirical formula tell us which elements are present in a compound and gives us the simplest, whole-number ratio of the atoms of these elements in the compound.

Ans: True Category: Medium