Chemistry - Summative Practice and Review for Chapter 4 and 5

Matching

Match each item with the correct statement below.

a. proton
b. isotope
c. atom number
d. electron
e. neutron
f. atomic mass
g. atom
h. nucleus

____ 1. a negatively charged subatomic particle

____ 2. a subatomic particle with no charge

____ 3. the central part of an atom, containing protons and neutrons

____ 4. the total number of protons and neutrons in the nucleus of an atom

____ 5. the number of protons in the nucleus of an element

Match each item with the correct statement below.

a. atomic orbital
b. aufbau principle
c. electron configuration
d. ground state
e. Pauli exclusion principle
f. quantum

____ 6. region of high probability of finding an electron

____ 7. discrete bundle of electromagnetic energy

____ 8. tendency of electrons to enter orbitals of lowest energy first

____ 9. arrangement of electrons around atomic nucleus

____ 10. each orbital has at most two electrons

Multiple Choice

Identify the choice that best completes the statement or answers the question.

____ 11. Which of the following was NOT among Democritus's ideas?
a. Matter consists of tiny particles called atoms.
b. Atoms are indivisible.
c. Atoms retain their identity in a chemical reaction.
d. Atoms are indestructible.

____ 12. Which of the following was originally a principle of Dalton's atomic theory, but had to be revised about a century ago?
a. Atoms are tiny indivisible particles.
b. Atoms of the same element are identical.
c. Compounds are made by combining atoms.
d. Atoms of different elements can combine with one another in simple whole number ratios.

____ 13. The comparison of the number of atoms in a copper coin the size of a penny with the number of people on Earth is made to illustrate which of the following?

a. that atoms are indivisible
b. that atoms are very small
c. that atoms are very large
d. that in a copper penny, there is one atom for every person on Earth

____ 14. Which of the following is true about subatomic particles?
a. Electrons are negatively charged and are the heaviest subatomic particle.
b. Protons are positively charged and the lightest subatomic particle.
c. Neutrons have no charge and are the lightest subatomic particle.
d. The mass of a neutron nearly equals the mass of a proton.

____ 15. All atoms are ____.
a. positively charged, with the number of protons exceeding the number of electrons
b. negatively charged, with the number of electrons exceeding the number of protons
c. neutral, with the number of protons equaling the number of electrons
d. neutral, with the number of protons equaling the number of electrons, which is equal to the number of neutrons

____ 16. The particles that are found in the nucleus of an atom are ____.
a. neutrons and electrons
b. electrons only
c. protons and neutrons
d. protons and electrons

____ 17. An element has an atomic number of 76. The number of protons and electrons in a neutral atom of the element are ____.
a. 152 protons and 76 electrons
b. 76 protons and 0 electrons
c. 38 protons and 38 electrons
d. 76 protons and 76 electrons

____ 18. The mass number of an element is equal to ____.
a. the total number of electrons in the nucleus
b. the total number of protons and neutrons in the nucleus
c. less than twice the atomic number
d. a constant number for the lighter elements

____ 19. Which of the following statements is NOT true?
a. Atoms of the same element can have different masses.
b. Atoms of isotopes of an element have different numbers of protons.
c. The nucleus of an atom has a positive charge.
d. Atoms are mostly empty space.

____ 20. How is the number of neutrons in the nucleus of an atom calculated?
a. Add the number of electrons and protons together.
b. Subtract the number of electrons from the number of protons.
c. Subtract the number of protons from the mass number.
d. Add the mass number to the number of electrons.

____ 21. In which of the following is the number of neutrons correctly represented?
a. $^{19}_{9}$F has 0 neutrons.
b. $^{75}_{33}$As has 108 neutrons.
c. $^{24}_{12}$Mg has 24 neutrons.
d. $^{238}_{92}$U has 146 neutrons.

____ 22. Which of the following isotopes has the same number of neutrons as phosphorus-31?
a. $^{32}_{15}$P
c. $^{29}_{14}$Si

b. $^{32}_{16}S$ d. $^{28}_{14}Si$

____ 23. What unit is used to measure weighted average atomic mass?
a. amu c. angstrom
b. gram d. nanogram

____ 24. How many energy sublevels are in the second principal energy level?
a. 1 c. 3
b. 2 d. 4

____ 25. What is the maximum number of electrons in the second principal energy level?
a. 2 c. 18
b. 8 d. 32

____ 26. What is the number of electrons in the outermost energy level of an oxygen atom?
a. 2 c. 6
b. 4 d. 8

____ 27. If three electrons are available to fill three empty 2*p* atomic orbitals, how will the electrons be distributed in the three orbitals?
a. one electron in each orbital
b. two electrons in one orbital, one in another, none in the third
c. three in one orbital, none in the other two
d. Three electrons cannot fill three empty 2*p* atomic orbitals.

____ 28. Stable electron configurations are likely to contain ____.
a. filled energy sublevels
b. fewer electrons than unstable configurations
c. unfilled *s* orbitals
d. electrons with a clockwise spin

____ 29. Emission of light from an atom occurs when an electron ____.
a. drops from a higher to a lower energy level
b. jumps from a lower to a higher energy level
c. moves within its atomic orbital
d. falls into the nucleus

____ 30. The atomic emission spectra of a sodium atom on Earth and of a sodium atom in the sun would be ____.
a. the same
b. different from each other
c. the same as those of several other elements
d. the same as each other only in the ultraviolet range

____ 31. As a consequence of the discovery of the nucleus by Rutherford, which model of the atom is thought to be true?
a. Protons, electrons, and neutrons are evenly distributed throughout the volume of the atom.
b. The nucleus is made of protons, electrons, and neutrons.
c. Electrons are distributed around the nucleus and occupy almost all the volume of the atom.
d. The nucleus is made of electrons and protons.

____ 32. The atomic mass of an element depends upon the ____.
a. mass of each electron in that element
b. mass of each isotope of that element

c. relative abundance of protons in that element
d. mass and relative abundance of each isotope of that element

____ 33. How are the frequency and wavelength of light related?
a. They are inversely proportional to each other.
b. Frequency equals wavelength divided by the speed of light.
c. Wavelength is determined by dividing frequency by the speed of light.
d. They are directly proportional to each other.

____ 34. The light given off by an electric discharge through sodium vapor is ____.
a. a continuous spectrum
b. an emission spectrum
c. of a single wavelength
d. white light

____ 35. Which of the following quantum leaps would be associated with the greatest energy of emitted light?
a. n = 5 to n = 1
b. n = 4 to n = 5
c. n = 2 to n = 5
d. n = 5 to n = 4

____ 36. Which variable is directly proportional to frequency?
a. wavelength
b. velocity
c. position
d. energy

____ 37. The nucleus of an atom is ____.
a. the central core and is composed of protons and neutrons
b. positively charged and has more protons than neutrons
c. negatively charged and has a high density
d. negatively charged and has a low density

____ 38. The atomic number of an element is the total number of which particles in the nucleus?
a. neutrons
b. protons
c. electrons
d. protons and electrons

____ 39. Isotopes of the same element have different ____.
a. numbers of neutrons
b. numbers of protons
c. numbers of electrons
d. atomic numbers

____ 40. Isotopes of the same element have different ____.
a. positions on the periodic table
b. chemical behavior
c. atomic numbers
d. mass numbers

____ 41. In Bohr's model of the atom, where are the electrons and protons located?
a. The electrons move around the protons, which are at the center of the atom.
b. The electrons and protons move throughout the atom.
c. The electrons occupy fixed positions around the protons, which are at the center of the atom.
d. The electrons and protons are located throughout the atom, but they are not free to move.

____ 42. The principal quantum number indicates what property of an electron?
a. position
b. speed
c. energy level
d. electron cloud shape

____ 43. What types of atomic orbitals are in the third principal energy level?
a. *s* and *p* only
b. *p* and *d* only
c. *s*, *p*, and *d* only
d. *s*, *p*, *d*, and *f*

____ 44. What is the next atomic orbital in the series 1*s*, 2*s*, 2*p*, 3*s*, 3*p*?
a. 2*d*
b. 3*d*
c. 3*f*
d. 4*s*

____ 45. Which scientist developed the quantum mechanical model of the atom?
a. Albert Einstein
b. Erwin Schrodinger
c. Niels Bohr
d. Ernest Rutherford

Short Answer

46. List the number of protons, neutrons, and electrons in $^{13}_{6}C$.

47. Give the electron configuration for a neutral atom of beryllium.

48. Give the electron configuration for a neutral atom of chlorine.

49. Give the electron configuration for a neutral atom of selenium.

50. The element chromium has four naturally occurring isotopes. Use the relative abundance of each to calculate the average atomic mass of chromium.

^{50}Cr = 4.34%, ^{52}Cr = 83.79%, ^{53}Cr = 9.50%, ^{54}Cr = 2.37%.

51. Write the electron configuration for chromium.

52. What is the relative charge of a proton?

53. How many protons are present in an atom of Be-9?

54. Use the periodic table to determine the number of neutrons in nitrogen-14.

55. How many neutrons are present in an atom of the isotope $^{235}_{92}\text{U}$?

56. Calculate the number of neutrons in ^{210}Pb.

Essay

57. What observations by Rutherford led to the hypothesis that atoms are mostly empty space, and that almost all of the mass of the atom is contained in an atomic nucleus?

58. In what way are two isotopes of the same element different? Explain why isotopes of the same element have the same chemical behavior.

59. Describe the shapes and relative energies of the *s*, *p*, *d*, and *f* atomic orbitals.

60. Explain the rules that determine how electron are arranged around the nuclei of atoms.

Chemistry - Summative Practice and Review for Chapter 4 and 5
Answer Section

MATCHING

1. ANS: D PTS: 1 DIF: L1 REF: p. 104
   OBJ: 4.2.1 Identify three types of subatomic particle. STA: Ch.1 | Ch.11
2. ANS: E PTS: 1 DIF: L1 REF: p. 106
   OBJ: 4.2.1 Identify three types of subatomic particle. STA: Ch.1 | Ch.11
3. ANS: H PTS: 1 DIF: L1 REF: p. 106 | p. 107
   OBJ: 4.2.1 Identify three types of subatomic particle. | 4.2.2 Describe the structure of atoms according to the Rutherford model. STA: Ch.1 | Ch.11
4. ANS: F PTS: 1
5. ANS: C PTS: 1

6. ANS: A PTS: 1 DIF: L1 REF: p. 130 | p. 131
   OBJ: 5.1.2 Identify the new proposal in the Bohr model of the atom.
   STA: Ch.1.e
7. ANS: F PTS: 1 DIF: L1 REF: p. 145
   OBJ: 5.1.3 Describe the energies and positions of electrons according to the quantum mechanical model.
   STA: Ch.1.e
8. ANS: B PTS: 1 DIF: L1 REF: p. 133
   OBJ: 5.1.3 Describe the energies and positions of electrons according to the quantum mechanical model. | 5.2.1 Describe how to write the electron configuration for an atom.
   STA: Ch.1.j
9. ANS: C PTS: 1 DIF: L1 REF: p. 133
   OBJ: 5.2.1 Describe how to write the electron configuration for an atom.
   STA: Ch.1.e
10. ANS: E PTS: 1 DIF: L1 REF: p. 134
    OBJ: 5.2.1 Describe how to write the electron configuration for an atom.
    STA: Ch.1.e

MULTIPLE CHOICE

11. ANS: C PTS: 1 DIF: L2 REF: p. 101
    OBJ: 4.1.1 Describe Democritus's ideas about atoms.
12. ANS: A PTS: 1 DIF: L2 REF: p. 104
    OBJ: 4.1.2 Explain Dalton's atomic theory.
13. ANS: B PTS: 1 DIF: L2 REF: p. 103
    OBJ: 4.1.3 Identify the special instruments necessary to observe individual atoms.
14. ANS: D PTS: 1 DIF: L2 REF: p. 104 | p. 105 | p. 106
    OBJ: 4.2.1 Identify three types of subatomic particle. STA: Ch.1.a
15. ANS: C PTS: 1 DIF: L3 REF: p. 106
    OBJ: 4.2.1 Identify three types of subatomic particle. STA: Ch.1
16. ANS: C PTS: 1 DIF: L2 REF: p. 106 | p. 107
    OBJ: 4.2.1 Identify three types of subatomic particle. | 4.2.2 Describe the structure of atoms according to the Rutherford model. STA: Ch.11.a
17. ANS: D PTS: 1 DIF: L1 REF: p. 110

OBJ: 4.3.1 Explain what makes elements and isotopes different from each other.
STA: Ch.1.a

18. ANS: B PTS: 1 DIF: L2 REF: p. 111
OBJ: 4.3.1 Explain what makes elements and isotopes different from each other.
STA: Ch.1.a

19. ANS: B PTS: 1 DIF: L2 REF: p. 110 | p. 112 | p. 113
OBJ: 4.3.1 Explain what makes elements and isotopes different from each other.
STA: Ch.11.c

20. ANS: C PTS: 1 DIF: L2 REF: p. 111
OBJ: 4.3.2 Calculate the number of neutrons in an atom.

21. ANS: D PTS: 1 DIF: L2 REF: p. 112 | p. 113
OBJ: 4.3.2 Calculate the number of neutrons in an atom.

22. ANS: B PTS: 1 DIF: L3 REF: p. 111
OBJ: 4.3.2 Calculate the number of neutrons in an atom. STA: Ch.11.c

23. ANS: A PTS: 1 DIF: L1 REF: p. 115
OBJ: 4.3.3 Calculate the atomic mass of an element.

24. ANS: B PTS: 1 DIF: L2 REF: p. 131
OBJ: 5.1.3 Describe the energies and positions of electrons according to the quantum mechanical model.
STA: Ch.1.i

25. ANS: B PTS: 1 DIF: L3 REF: p. 132
OBJ: 5.1.3 Describe the energies and positions of electrons according to the quantum mechanical model.
STA: Ch.1.i

26. ANS: C PTS: 1 DIF: L2 REF: p. 134 | p. 135
OBJ: 5.2.1 Describe how to write the electron configuration for an atom.
STA: Ch.1.g

27. ANS: A PTS: 1 DIF: L3 REF: p. 134
OBJ: 5.2.1 Describe how to write the electron configuration for an atom.
STA: Ch.1.g | Ch.1.i

28. ANS: A PTS: 1 DIF: L1 REF: p. 136
OBJ: 5.2.2 Explain why the actual electron configurations for some elements differ from those predicted by the aufbau principle. STA: Ch.1.g

29. ANS: A PTS: 1 DIF: L2 REF: p. 141
OBJ: 5.3.2 Identify the source of atomic emission spectra. STA: Ch.1.j

30. ANS: A PTS: 1 DIF: L2 REF: p. 141
OBJ: 5.3.2 Identify the source of atomic emission spectra. | 5.3.3 Explain how the frequencies of light are related to changes in electron energies. STA: Ch.1.j

31. ANS: C PTS: 1 DIF: L2 REF: p. 108
OBJ: 4.2.2 Describe the structure of atoms according to the Rutherford model.
STA: Ch.1.h

32. ANS: D PTS: 1 DIF: L2 REF: p. 115
OBJ: 4.3.3 Calculate the atomic mass of an element.

33. ANS: A PTS: 1 DIF: L2 REF: p. 139
OBJ: 5.3.1 Describe the relationship between the wavelength and frequency of light.
STA: Ch.1.j

34. ANS: B PTS: 1 DIF: L2 REF: p. 141
OBJ: 5.3.2 Identify the source of atomic emission spectra. STA: Ch.1.j

35. ANS: A PTS: 1 DIF: L2 REF: p. 143
OBJ: 5.3.3 Explain how the frequencies of light are related to changes in electron energies.
STA: Ch.1.j

36. ANS: D PTS: 1 DIF: L3 REF: p. 142
OBJ: 5.3.3 Explain how the frequencies of light are related to changes in electron energies.
STA: Ch.1.j
37. ANS: A PTS: 1 DIF: L2 REF: p. 107 | p. 108
OBJ: 4.2.2 Describe the structure of atoms according to the Rutherford model.
STA: Ch.1.e
38. ANS: B PTS: 1 DIF: L1 REF: p. 110
OBJ: 4.3.1 Explain what makes elements and isotopes different from each other.
STA: Ch.1.a
39. ANS: A PTS: 1 DIF: L1 REF: p. 112 | p. 113
OBJ: 4.3.1 Explain what makes elements and isotopes different from each other.
STA: Ch.11.c
40. ANS: D PTS: 1 DIF: L1 REF: p. 112 | p. 113
OBJ: 4.3.1 Explain what makes elements and isotopes different from each other.
STA: Ch.11.c
41. ANS: A PTS: 1 DIF: L2 REF: p. 128
OBJ: 5.1.2 Identify the new proposal in the Bohr model of the atom.
STA: Ch.1.i
42. ANS: C PTS: 1 DIF: L2 REF: p. 131
OBJ: 5.1.3 Describe the energies and positions of electrons according to the quantum mechanical model.
STA: Ch.1.i
43. ANS: C PTS: 1 DIF: L2 REF: p. 131
OBJ: 5.2.1 Describe how to write the electron configuration for an atom.
STA: Ch.1.i
44. ANS: D PTS: 1 DIF: L2 REF: p. 133
OBJ: 5.2.1 Describe how to write the electron configuration for an atom.
STA: Ch.1.i
45. ANS: B PTS: 1 DIF: L1 REF: p. 130
OBJ: 5.3.4 Distinguish between quantum mechanics and classical mechanics.
STA: Ch.1.i

SHORT ANSWER

46. ANS:
protons: 6; neutrons: 7; electrons: 6

PTS: 1 DIF: L2 REF: p. 110 | p. 111
OBJ: 4.3.1 Explain what makes elements and isotopes different from each other. | 4.3.2 Calculate the number of neutrons in an atom. STA: Ch.1.a
47. ANS:
$1s^2 2s^2$

PTS: 1 DIF: L1 REF: p. 133 | p. 134
OBJ: 5.2.1 Describe how to write the electron configuration for an atom.
STA: Ch.1.g
48. ANS:
$1s^2 2s^2 2p^6 3s^2 3p^5$

PTS: 1 DIF: L2 REF: p. 133 | p. 134

OBJ: 5.2.1 Describe how to write the electron configuration for an atom.
STA: Ch.1.g

49. ANS:
$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^4$

PTS: 1 DIF: L2 REF: p. 133 | p. 134
OBJ: 5.2.1 Describe how to write the electron configuration for an atom.
STA: Ch.1.g

50. ANS:
50 amu × 0.0434 = 2.17 amu
52 amu × 0.8379 = 43.57 amu
53 amu × 0.0950 = 5.04 amu
54 amu × 0.0237 = 1.28 amu

= 52.06 amu
≈ 52 amu

PTS: 1 DIF: L3 REF: p. 116 | p. 117
OBJ: 4.3.3 Calculate the atomic mass of an element.

51. ANS:
$1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$

PTS: 1 DIF: L3 REF: p. 134 | p. 135 | p. 136
OBJ: 5.2.2 Explain why the actual electron configurations for some elements differ from those predicted by the aufbau principle. STA: Ch.1.g

NUMERIC RESPONSE

52. ANS: 1+

PTS: 1 DIF: L1 REF: p. 106
OBJ: 4.2.1 Identify three types of subatomic particle. STA: Ch.11.a

53. ANS: 4

PTS: 1 DIF: L1 REF: p. 110 | p. 111
OBJ: 4.3.1 Explain what makes elements and isotopes different from each other.
STA: Ch.1.a

54. ANS: 7

PTS: 1 DIF: L2 REF: p. 111
OBJ: 4.3.2 Calculate the number of neutrons in an atom. | 4.3.4 Explain why chemists use the periodic table. STA: Ch.1.a

55. ANS: 143

PTS: 1 DIF: L2 REF: p. 111
OBJ: 4.3.2 Calculate the number of neutrons in an atom. STA: Ch.11.c

56. ANS: 128

PTS: 1 DIF: L2 REF: p. 112 | p. 113

OBJ: 4.3.2 Calculate the number of neutrons in an atom. STA: Ch.11.c

ESSAY

57. ANS:
Rutherford's gold-foil experiment led to this hypothesis. Alpha particles were observed to mostly pass through a gold foil, which suggests that the volume of individual gold atoms consists mainly of empty space. The observation that some alpha particles were scattered at large angles led to the suggestion that the gold atom has a central core, or nucleus, composed of a concentrated mass capable of deflecting the alpha particles.

PTS: 1 DIF: L3 REF: p. 107
OBJ: 4.2.2 Describe the structure of atoms according to the Rutherford model.
STA: Ch.1.h

58. ANS:
Isotopes of the same element have different numbers of neutrons, and therefore, different mass numbers and different atomic masses. Isotopes of the same element have the same number of protons and electrons. The electrons, not the neutrons, are responsible for an element's chemical behavior.

PTS: 1 DIF: L3 REF: p. 112
OBJ: 4.3.1 Explain what makes elements and isotopes different from each other.
STA: Ch.11.c

59. ANS:
An *s* orbital has the shape of a sphere and is the orbital having the lowest energy. A *p* orbital is dumbbell-shaped and has the next higher energy. A *d* orbital has a more complex shape and a higher energy than either an *s* orbital or a *p* orbital. An *f* orbital has the highest energy of these four orbital types; this orbital has a very complex shape.

PTS: 1 DIF: L2 REF: p. 131 | p. 132
OBJ: 5.1.4 Describe how the shapes of orbitals at different sublevels differ.
STA: Ch.1.i

60. ANS:
According to the aufbau principle, electrons enter orbitals of lowest energy first. According to the Pauli exclusion principle, an orbital may contain at most two electrons. According to Hund's rule, one electron will enter each orbital of equal energy before electrons begin to pair up.

PTS: 1 OBJ: 5.2.1 STA: Ch.1.i