Semester Exam Practice Questions

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

1. Which of the following is not a material?
   a. air  c. salt
   b. heat  d. water

2. Orange juice can best be classified as a(n) __________.
   a. substance  c. element
   b. mixture  d. compound

3. A chemical change must produce a __________.
   a. solution  c. new substance
   b. gas  d. mixture

4. Which of the following is a chemical property of magnesium?
   a. oxidizes to produce a white powder  c. is ductile
   b. has a density of 1.738 g/cm³  d. melts at 650°C

5. Which of the following is a homogeneous mixture?
   a. iron filings  c. sand in water
   b. sugar in water  d. dry ice

6. The number of naturally occurring elements currently known is __________.
   a. 54  c. 103
   b. 88  d. 154

7. Which of the following is an example of a chemical change?
   a. wood burning  c. cheese being shredded
   b. snow melting  d. an orange being squeezed

8. Which of the following cannot be separated into individual substances by a physical change?
   a. heterogeneous mixture  c. solution
   b. compound  d. homogeneous mixture

9. Which of the following is a physical change?
   a. bread toasting  c. an egg frying
   b. butter melting  d. an apple being digested

10. A substance composed of only one kind of atom is a(n) __________.
    a. element  c. mixture
    b. compound  d. solution

11. A reaction that releases heat is said to __________.
    a. be exothermic  c. be endothermic
    b. be nonspontaneous  d. run uphill

12. Which of the following ideas is not retained in the current theory of atomic structure?
    a. Electrons can absorb or emit energy only in whole numbers of photons.
    b. Atoms have a central, positively charged nucleus.
    c. Electrons move around the nucleus as planets orbit the sun.
    d. Most of the volume of an atom is empty space.
13. The electric charge and mass number of a neutron are, respectively, _______.
   a. +1 and -1  b. -1 and +1  c. +1 and 0  d. 0 and +1

14. What is the approximate atomic mass of an isotope of lithium that has 3 electrons, 3 protons, and 5 neutrons?
   a. 5 amu  b. 6 amu  c. 8 amu  d. 11 amu

15. Two isotopes of an element have different ________.
   a. atomic numbers  b. mass numbers  c. numbers of electrons  d. numbers of protons

16. Einstein’s theory, summarized by the equation $E=mc^2$, indicates that ________.
   a. matter can neither be created nor destroyed  b. energy exists in discrete packets called quanta  
   c. energy is proportional to the wavelength of the radiation  d. mass and energy are equivalent

17. Heisenberg’s uncertainty principle pointed out that it is impossible to know the exact ________.
   a. position and momentum of an electron at the same time  
   b. mass and charge of an electron at the same time  
   c. momentum and wavelength of an electron at the same time  d. wavelength and charge of an electron at the same time

18. The principal quantum number best describes which of the following characteristics?
   a. shape of the electron cloud  b. size of the electron cloud  
   c. spin of the electron  d. intensity of charge of the electron cloud

19. In the wave-mechanical view of atomic structure, the pathway or position of an electron is best represented as ________.
   a. a circular orbit with a specific diameter  b. an elliptical orbit with the nucleus at one focal point of the ellipse  
   c. a series of most probable positions represented by a cloud  d. a straight line that radiates out from the center like a spoke in a wheel

20. What is the maximum number of electrons that can occupy energy level 4?
   a. 4  b. 8  c. 16  d. 32

21. Which of the following designates the sublevels that exist in energy level 3?
   a. s, d  b. p, f  c. s, p, d  d. p, d, f

22. How many pairs of electrons can a $d$ sublevel hold?
   a. 1  b. 3  c. 5  d. 7

23. According to the Pauli exclusion principle, no two electrons in the same atom can have the same ________.
   a. average distance from the nucleus  b. orbital locations  
   c. spin  d. set of quantum numbers
24. The electron configuration of the nitrogen atom \((Z = 7)\) is ________.
   a. \(1s^22s^23p^3\)  
   b. \(1s^22s^22p^3\)  
   c. \(1s^22s^23p^1\)  
   d. \(1s^22s^23s^3\)

25. The Lewis electron dot diagram for calcium is ________.
   a. \(Ca\cdot\)  
   b. \(Ca:\)  
   c. \(:Ca\cdot\)  
   d. \(\cdot Ca\cdot\)

26. \(X\): Which of the following is a possible ending of an electron configuration for an element with the Lewis structure shown?
   a. \(4s^23d^{10}4p^1\)  
   b. \(2s^22p^2\)  
   c. \(3s^23p^6\)  
   d. \(5s^24d^3\)

27. The modern periodic law states that the properties of the elements are a periodic function of their ________.
   a. atomic radius  
   b. atomic number  
   c. atomic mass  
   d. atomic charge

28. In the modern periodic table, the elements within a column have ________.
   a. similar electron configurations  
   b. similar atomic masses  
   c. the same number of energy levels  
   d. similar atomic diameters

29. Examine the following electron configuration and choose the correct location of the element it represents in the periodic table: \(1s^22s^22p^63s^23p^44s^23d^{10}4p^65s^24d^7\)
   a. row 7, column 4 (Rf)  
   b. row 4, column 7 (Mn)  
   c. row 5, column 7 (Tc)  
   d. row 5, column 9 (Rh)

30. In the periodic table, all of the elements in a horizontal row are referred to as a ________.
   a. period  
   b. group  
   c. family  
   d. triad

31. In general, how many electrons should an atom have in its outer level to be chemically stable?
   a. 4  
   b. 8  
   c. 12  
   d. 10

32. Elements with three or fewer electrons in the outer level are considered to be ________.
   a. nonmetals  
   b. metals  
   c. metalloids  
   d. chalcogens

33. Atoms of which of the following elements achieve greater chemical stability by having two half-full sublevels?
   a. chromium  
   b. copper  
   c. zinc  
   d. yttrium

34. Most exceptions to the electron-filling order indicated by an arrow diagram occur as a result of ________.
   a. the stability of eight electrons in the outer level  
   b. the special stability of a half-filled sublevel  
   c. the increased energy associated with higher principal quantum numbers  
   d. the increased electron capacity of higher energy levels
35. Which of the following is an example of a metalloid?
   a. I  c. Br
   b. B  d. In

36. The period number in the periodic table designates the _________.
   a. total nuclear charge
   b. maximum number of outer electrons in the row
   c. minimum number of outer electrons in the row
   d. principal quantum number for the outer electrons

37. Element X has the following electron configuration: 1s\(^2\)2s\(^2\)2p\(^6\)3s\(^2\)3p\(^6\)4s\(^2\)3d\(^{10}\)4p\(^6\)5s\(^2\)4d\(^{10}\)5p\(^6\). Which of the following correctly describes this element?
   a. stable nonmetal  c. stable metal
   b. unstable nonmetal  d. unstable metal

38. Which of the following represents the number of atoms of a given kind in a compound?
   a. oxidation number  c. subscript
   b. formula unit  d. coefficient

39. How many atoms of oxygen are in Al\(_2\)(SO\(_4\))\(_3\)?
   a. 12  c. 4
   b. 7  d. 1

40. An atom that has an electric charge is called a(n) __________.
   a. formula unit  c. binary compound
   b. ion  d. isotope

41. An ion with a charge of 3+ can combine with three other ions, if each of these ions has a charge of _____.
   a. 3-  c. 1-
   b. 3+  d. 1+

42. How many formula units are represented by 3K\(_2\)SO\(_3\)?
   a. one  c. three
   b. two  d. four

43. Which of the following could NOT be an empirical formula?
   a. CuSO\(_4\) • 5H\(_2\)O  c. C\(_2\)H\(_6\)
   b. Al\(_2\)O\(_3\)  d. H\(_3\)PO\(_4\)

44. The Avogadro constant is __________.
   a. 6.63 x 10\(^{-34}\)  c. 2.998 x 10\(^8\)
   b. 1.66 x 10\(^{-24}\)  d. 6.02 x 10\(^{23}\)

45. The formula for borax is Na\(_2\)B\(_4\)O\(_7\) • 10H\(_2\)O. The number of water molecules in two moles of borax formula units is __________.
   a. 10  c. 6.02 x 10\(^{23}\)
   b. 20  d. 1.20 x 10\(^{25}\)

46. The simplest ratio of atoms in a compound is given by a(n) __________.
   a. empirical formula  c. molecular mass
   b. molecular formula  d. formula mass

47. When a measurement that has six significant digits is divided by a measurement that has three significant digits, how many significant digits should the answer have?
   a. two  c. six
   b. three  d. nine
48. The formula mass of magnesium chloride, MgCl₂, is __________.
   a. 59.8 amu  
   b. 76.4 amu  
   c. 95.2 amu  
   d. 125.8 amu

49. If one molecule of NH₃ has a mass of 17.0 g/mol, what is the mass of 6.02 x 10²³ molecules of NH₃?
   a. 2.82 g  
   b. 17.0 g  
   c. 102 g  
   d. 2.82 x 10⁻²⁵ g

50. Which of the following statements explains why chemists do not count atoms and molecules directly?
   a. Matter is neither created nor destroyed in a chemical reaction.  
   b. All of the relationships in a chemical reaction can be expressed as mass ratios.  
   c. Atoms and molecules are extremely small.  
   d. Reactions occur one atom at a time.

51. Which of the following could be used as a conversion factor in converting from kilograms to grams?
   a. 1000g  
   b. 1kg / 1000g  
   c. 1kg / 1000g  
   d. 100g / 1kg

52. In the reaction 2KClO₃ → 2KCl + 3O₂, oxygen is a __________.
   a. reactant  
   b. coefficient  
   c. product  
   d. subscript

53. A chemical equation is balanced when __________.
   a. the equation shows an equal number of atoms for each element on both sides  
   b. at least one substance in each of the three physical states is represented  
   c. the total number of moles of the reactants equals the moles of the products  
   d. the mass of each reactant equals the mass of each product

54. In the equation 2C₂H₂(g) + 5O₂(g) → 4CO₂(g) + H₂O(l), the coefficient for oxygen is __________.
   a. 5  
   b. 2  
   c. (g)  
   d. 10

55. What coefficient should be placed before carbon monoxide when the following equation is balanced?
   C + SO₂ → CS₂ + CO
   a. 2  
   b. 3  
   c. 4  
   d. 5

56. The coefficient that should be placed before manganese when the following equation is balanced is _____.
   Al + MnO → Al₂O₃ + Mn
   a. 1  
   b. 2  
   c. 3  
   d. 4

57. In the equation 2Fe + 3H₂O → Fe₂O₃ + 3H₂, iron is a __________.
   a. subscript  
   b. reactant  
   c. product  
   d. coefficient

Short Answer

58. Describe how the atomic model changed as a result of research performed or interpreted by Thomson, Rutherford, and Bohr.

59. Although the outer-energy-level configuration of He is 1s², this element is placed in Group VIIIA, rather than in Group IIA. Explain this seeming inconsistency.
Problem

60. Give the answer to the following calculations with the correct number of significant digits.
   a) 9.04 g - 8.2 g + 21.954 g =
   b) 9.2 cm³ x 4.026 g/cm³ =
   c) 8.27 g/cm³ x (8.321 cm³ + 4.026 cm³) =

61. Calculate the average atomic mass of an element whose two isotopes naturally occur in the following proportions and have the following atomic masses: 25.0% Isotope 1, atomic mass 64.9u; 75.0% Isotope 2, atomic mass 67.1u.

62. Find the number of protons, electrons, and neutrons in a neutral atom of chlorine-35, atomic number 17.

63. Find the atomic number and atomic mass of an atom containing 25 protons, 25 electrons, and 26 neutrons.

64. A neutral atom has an electron configuration that ends in 4s²3d⁸.
   a) What is the atomic number of this atom?
   b) How many orbitals are partially filled?
   c) What element does this atom represent?

65. A laboratory technician ran an analysis of a germicide socked by a janitorial service. The technician determined that the effective ingredient in the germicide was a compound that was 33% sodium, 36% arsenic, and 31% oxygen. What is the empirical formula of this compound?

66. During the late 19th century cobalt blue glassware was popular. Cobalt blue is considered to be the most durable of all blue pigments. It is a mixture of compounds including the compound Co(AlO₂)₂. What is the percentage composition of this compound?

67. Calculate the molecular mass of methanol, CH₃OH.

68. If 0.940 g of a compound containing only magnesium and oxygen consists of 0.564 g Mg, what is the compound’s empirical formula?
Semester Exam Practice Questions
Answer Section

MULTIPLE CHOICE

1. B
2. B
3. C
4. A
5. B
6. B
7. A
8. B
9. B
10. A
11. A
12. C
13. D
14. C
15. B
16. D
17. A
18. B
19. C
20. D
21. C
22. C
23. D
24. B
25. B
26. A
27. B
28. A
29. D
30. A
31. B
32. B
33. A
34. B
35. B
36. D
37. A
38. C
SHORT ANSWER

58. Thomson discovered the existence of electrons; Rutherford proposed that the atom has a dense nucleus surrounded by electrons; Bohr discovered that the electrons were positioned around the nucleus in well-defined energy levels.

59. Since the first energy level can hold a maximum of two electrons, the properties of He, with its two outermost electrons, more closely resemble those of the elements in Column 18, whose outer levels hold their maximum number of electrons. Like the other Column-18 elements, He displays a relative lack of reactivity, owing to its full outer energy level.

PROBLEM

60. a) 22.8 g  
   b) 37 g  
   c) 102 g

61. Average atomic mass = \((25.0 \times 64.9u) + (75.0 \times 67.1u)) / 100 = 66.6u\)

62. 17 protons  
    17 electrons (if neutral)  
    18 neutrons

63. atomic number = 25  
    atomic mass = 51
64. a) atomic number 28
   b) 2 d orbitals
   c) nickel
65. Na₃AsO₄
66. Co: 33.3%
    Al: 30.5%
    O: 36.2%
67. 32.0 g/mol
68. 0.0232 mol Mg

0.0235 mol O

MgO