MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) Of the following, only ________ is a chemical reaction.
   A) tarnishing of silver
   B) dissolving sugar in water
   C) crushing of stone
   D) dropping a penny into a glass of water
   E) melting of lead

   Answer: A

2) The gold foil experiment performed in Rutherford’s lab ________.
   A) led to the discovery of the atomic nucleus
   B) utilized the deflection of beta particles by gold foil
   C) was the basis for Thompson’s model of the atom
   D) confirmed the plum–pudding model of the atom
   E) proved the law of multiple proportions

   Answer: A

3) A molecular formula always indicates ________.
   A) how many of each atom are in a molecule
   B) which atoms are attached to which in a molecule
   C) the simplest whole-number ratio of different atoms in a compound
   D) the isotope of each element in a compound
   E) the geometry of a molecule

   Answer: A

4) Which species below is the sulfite ion?
   A) SO$_2^-$
   B) H$_2$S
   C) S$^2$-
   D) H$_2$SO$_4$
   E) SO$_3^{2-}$

   Answer: E

5) For which of the following can the composition vary?
   A) pure substance
   B) homogeneous mixture
   C) both homogeneous and heterogeneous mixtures
   D) element
   E) heterogeneous mixture

   Answer: C

6) Which one of the following is a nonmetal?
   A) Zn
   B) Au
   C) Pb
   D) Ca
   E) I

   Answer: E
7) The combustion of propane \((C_4H_{10})\) produces \(CO_2\) and \(H_2O\):

\[
2C_4H_{10} (g) + 13O_2 (g) \rightarrow 8CO_2 (g) + 10H_2O (g)
\]

The reaction of 0.75 mol of \(C_4H_{10}\) will produce ________ mol of \(H_2O\).

A) 0.75  B) 5.0  C) 1.5  D) 2.5  E) 3.75

Answer: E

8) Which of the following are a physical properties?

1) The density of a liquid
2) The temperature of the air
3) The color of a solution
4) The weight of a crystal

A) 2, 3  B) 1, 2, 3, 4  C) 1, 4  D) 1, 2

Answer: B

9) Fluorine is a ________ and calcium is a ________.

A) metal, nonmetal  B) metal, metal  C) nonmetal, metal  D) metal, metalloid  E) metalloid, nonmetal

Answer: C

10) Of the following, ________ is the largest mass.

A) \(2.5 \times 10^{15}\) g
B) \(5 \times 10^{-2}\) mg
C) \(2.5 \times 10^{10}\) µg
D) \(2.5 \times 10^{12}\) ng
E) \(7 \times 10^{3}\) kg

Answer: A

11) The formula of nitrobenzene is \(C_6H_5NO_2\). The molecular weight of this compound is ________ amu.

A) 3.06  B) 123.11  C) 107.11  D) 43.03  E) 109.10

Answer: B

12) Of the three types of radioactivity characterized by Rutherford, which is/are not electrically charged?

A) \(\alpha\)-rays, \(\beta\)-rays, and \(\gamma\)-rays
B) \(\gamma\)-rays
C) \(\alpha\)-rays and \(\gamma\)-rays
D) \(\alpha\)-rays and \(\beta\)-rays
E) \(\alpha\)-rays

Answer: B
13) In the periodic table, the elements are arranged in _________.
   A) reverse alphabetical order
   B) order of increasing metallic properties
   C) order of increasing atomic number
   D) alphabetical order
   E) order of increasing neutron content
   Answer: C

14) Cathode rays are _________.
   A) protons
   B) electrons
   C) atoms
   D) neutrons
   E) x-rays
   Answer: B

15) In the following list, only ________ is not an example of matter.
   A) table salt
   B) light
   C) elemental phosphorus
   D) dust
   E) planets
   Answer: B

16) The STM was used in class to demonstrate that while atoms are very small, they can be visualized with modern instrumentation. What does STM stand for?
   A) Small Technology Microscope
   B) Electron Microscope
   C) Scanning Electron Microscope
   D) Scanning Tunneling Microscope
   Answer: D

17) The formula for the compound formed between aluminum ions and sulfate ions is _________.
   A) AlS
   B) Al₂(SO₄)₃
   C) AlSO₄
   D) Al₃(SO₄)₃
   E) Al(SO₄)₃
   Answer: B

18) The number 0.000816 has ________ significant figures.
   A) 6
   B) 5
   C) 7
   D) 3
   E) 2
   Answer: D

19) Predict the charge of the most stable ion of magnesium.
   A) +1
   B) -1
   C) +2
   D) +3
   E) -2
   Answer: C

20) Of the reactions below, which one is a decomposition reaction?
   A) NH₄Cl → NH₃ + HCl
   B) Cd(NO₃)₂ + Na₂S → CdS + 2NaNO₃
   C) 2Mg + O₂ → 2MgO
   D) 2CH₄ + 4O₂ → 2CO₂ + 4H₂O
   E) 2N₂ + 3H₂ → 2NH₃
   Answer: A
21) Elements in Group 1A are known as the __________.
   A) noble gases
   B) chalcogens
   C) alkali metals
   D) halogens
   E) alkaline earth metals

   Answer: C

22) A molecule of ammonia contains hydrogen and nitrogen in a 1:3 ratio by mass. This is a statement of __________.
   A) the law of constant composition
   B) the law of multiple proportions
   C) the law of conservation of energy
   D) the law of conservation of mass
   E) none of the above

   Answer: A

23) The correct name for HClO₂ is __________.
   A) hydrochloric acid
   B) hydrochlorous acid
   C) chlorous acid
   D) chloric acid
   E) perchloric acid

   Answer: C

24) The atom contains __________.
   A) electrons
   B) protons and neutrons
   C) protons
   D) protons, neutrons, and electrons
   E) protons and electrons

   Answer: D

25) When the following equation is balanced, the coefficients are __________.

   \[ \text{Al(NO}_3\text{)}_3 + \text{Na}_2\text{S} \rightarrow \text{Al}_2\text{S}_3 + \text{NaNO}_3 \]

   A) 1, 1, 1
   B) 4, 6, 3, 2
   C) 2, 3, 1, 6
   D) 2, 1, 3, 2
   E) 2, 3, 2, 3

   Answer: C

26) Which pair of elements would you expect to exhibit the greatest similarity in their physical and chemical properties?
   A) F, He
   B) Si, P
   C) K, Ca
   D) C, N
   E) O, S

   Answer: E
27) Consider the following selected postulates of Dalton’s atomic theory:
   (i) Each element is composed of extremely small particles called atoms.
   (ii) Atoms are indivisible.
   (iii) Atoms of a given element are identical.
   (iv) Atoms of different elements are different and have different properties.
Which of the postulates is(are) no longer valid?
   A) (iii) and (iv)
   B) (ii) only
   C) (iii) only
   D) (i) and (ii)
   E) (ii) and (iii)
Answer: E

28) Of the following, the smallest and lightest subatomic particle is the __________.
   A) alpha particle
   B) neutron
   C) electron
   D) nucleus
   E) proton
Answer: C

29) There should be ________ significant figures in the answer to the following computation.
\[
\frac{(10.07 + 7.395)}{2.5}
\]
   A) 1
   B) 2
   C) 3
   D) 4
   E) 5
Answer: B

30) The number with the most significant zeros is _________.
   A) 2.5100000
   B) 2.501 \times 10^{-7}
   C) 0.00002510
   D) 25000001
   E) 0.02500001
Answer: D

31) Which species below is the nitrate ion?
   A) NO₂⁻
   B) N³⁻
   C) NO₃⁻
   D) N₃⁻
   E) NH₄⁺
Answer: C

32) The formula weight of ammonium sulfate ((NH₄)₂SO₄) is ________ amu.
   A) 100
   B) 116
   C) 118
   D) 264
   E) 132
Answer: E

33) Which of the following about atoms is NOT a true statement
   A) Atoms are the building blocks of matter
   B) Each element is made up of various types of atoms
   C) A compound is made of two or more different kinds of elements
   D) Molecules are the smallest units of a substance
Answer: B
34) When the following equation is balanced, the coefficient of H₂S is _______.

\[ \text{FeCl}_3 (aq) + \text{H}_2\text{S} (g) \rightarrow \text{Fe}_2\text{S}_3 (s) + \text{HCl} (aq) \]

A) 1  
B) 5  
C) 2  
D) 4  
E) 3

Answer: E

35) Which formula/name pair is incorrect?

A) \text{Fe}_2(\text{SO}_3)_3 \quad \text{iron(III) sulfite}  
B) \text{FeS} \quad \text{iron(II) sulfide}  
C) \text{FeSO}_3 \quad \text{iron(II) sulfite}  
D) \text{Fe}_2(\text{SO}_4)_3 \quad \text{iron(III) sulfide}  
E) \text{FeSO}_4 \quad \text{iron(II) sulfate}  

Answer: D

36) A combination of sand, salt, and water is an example of a _______.

A) compound  
B) pure substance  
C) homogeneous mixture  
D) beach  
E) heterogeneous mixture  

Answer: E

37) The formula of a salt is XF. The X⁻ ion in this salt has 36 electrons. The metal X is _______.

A) \text{Zn}  
B) \text{Fe}  
C) \text{V}  
D) \text{Pd}  
E) \text{Rb}  

Answer: E

38) The element _______ is the most similar to magnesium in chemical and physical properties.

A) \text{Cs}  
B) \text{Ba}  
C) \text{At}  
D) \text{Rb}  
E) \text{Li}  

Answer: B

39) 6,020,000 neon atoms is _______ mol of neon atoms.

A) \(1.0 \times 10^{-17}\)  
B) \(1.0 \times 10^6\)  
C) \(6.0 \times 10^{23}\)  
D) 3  
E) \(1.7 \times 10^{-18}\)  

Answer: A

40) _______ typically form ions with a -1 charge.

A) Halogens  
B) Transition metals  
C) Alkaline earth metals  
D) Chalcogens  
E) Alkali metals  

Answer: A
SHORT ANSWER. Write the word or phrase that best completes each statement or calculate the answer the question showing all work (for max. partial credit).

41) The correct answer (reported to the proper number of significant figures) to the following is __________.

$$\frac{(2018 + 2002)}{(7.11 \times 9.72)} = \text{__________}$$

Answer: 58.2

42) Isotopes can be separated using what type of spectroscopic equipment?

Answer: Mass spectrometer

43) The density of aluminum is 2.7 g/cm$^3$. A piece of aluminum that occupies a volume of 21.4 mm$^3$ would have a mass of __________g.

Answer: 0.0578

44) What is the coefficient of O$_2$ when the following equation is completed and balanced? If 10 moles of O$_2$ were consumed how many moles of CO$_2$ were produced?

$$\text{C}_4\text{H}_8\text{O}_2 + \text{O}_2 \rightarrow \text{__________}$$

Answer: 5, 8 moles CO$_2$ produced

45) 5.78 kg/m$^3$ = __________ µg/cm$^3$

Answer: 5.78 $\times$ 10$^3$
46) If matter is uniform throughout, cannot be separated into other substances by physical processes, but can be decomposed into other substances by chemical processes, it is called a (an) _________.
Answer: compound

47) Predict the formula of the ionic compound that forms from carbonate and calcium.
Answer: CaCO₃

48) There are ________ carbons atoms in 25 molecules of C₄H₄S₂.
Answer: 100

49) A sample of CH₂F₂ with a mass of 19 g contains ________ atoms of C.
Answer: 2.2 × 10²³

50) Magnesium burns in air with a dazzling brilliance to produce magnesium oxide:

\[ \text{2Mg (s) + O}_2 \text{ (g) → 2MgO (s)} \]

When 3.00 g of magnesium burn in excess O₂, the mass of magnesium oxide produced is ________ g.
Answer: 4.98
51) \(3.435 \times 10^{-4} \text{ L} = \text{__________ nL}\)

Answer: \(3.435 \times 10^5 \text{ nL}\)

52) How many molecules of \(\text{CO}_2\) are there in \(3.10\) moles of \(\text{CO}_2\)

Answer: \(1.87 \times 10^{24}\)

53) Name the following:
   A) \(\text{K}_2\text{S}\) ___________________________
   B) \(\text{SO}_4^{2-}\) ____________________________
   C) \(\text{CO}_2\) ____________________________
   D) \(\text{PF}_6\) _____________________________
   E) \(\text{NaF}\) _____________________________

Answer: A) potassium sulfide B) sulfate ion C) carbon dioxide D) phosphorous hexafluoride E) sodium fluoride