4.1 True/False Questions

1) The smell of the ocean is caused by atoms.
Answer: True

2) The atom is the fundamental building block of everything we hear, feel, see, and experience.
Answer: True

3) An atom is the smallest identifiable unit of a compound.
Answer: False

4) John Dalton was the first person recorded as thinking that matter was ultimately composed of atoms.
Answer: False

5) John Dalton formalized an atomic theory that gained acceptance in the early 19th century.
Answer: True
6) You can continually divide matter into smaller and smaller pieces without ever coming to an end.
Answer: False

7) J.J. Thomson discovered the existence of protons.
Answer: False

8) Ernest Rutherford proved the existence of electrons.
Answer: False

9) The gold foil experiment proved that large regions of the atoms consisted of empty space.
Answer: True

10) The nucleus of an atom is a very small, dense region that contains over 99.9% of the atomic mass.
Answer: True

11) Protons and electrons each have a mass of 1 amu.
Answer: False
12) A positive charge attracts negative charges and repels other positive charges. 
Answer: True

13) The charges on electrons and neutrons cancel each other to give neutral atoms. 
Answer: False

14) If two atoms each contain different numbers of protons, the atoms must be from different elements. 
Answer: True

15) All carbon atoms have exactly 6 protons. 
Answer: True

16) The atomic number of nitrogen is 14.01. 
Answer: False

17) Mendeleev is best remembered for his pioneering work on determining atomic structure. 
Answer: False
18) Mendeleev's early periodic table predicted the existence of elements that had yet to be discovered.
Answer: True

19) Metals are located on the left side of the periodic table.
Answer: True

20) The elements within a group on the periodic table tend to have similar properties.
Answer: True

21) Group 2A elements are called alkali metals.
Answer: False

22) Aluminum is one of the most commonly used metalloids.
Answer: False

23) A cation forms when an atom gains a proton or loses an electron.
Answer: False
24) Halogens form anions with a 1- charge.
Answer: True

25) Isotopes are atoms of the same element that have a different numbers of neutrons.
Answer: True

26) The atomic mass of individual atoms of an element may vary.
Answer: True

27) The relative amount of each different isotope in a naturally occurring sample of an element is always the same.
Answer: True

28) All elements have three or more naturally occurring isotopes.
Answer: False

29) The atomic mass of a single carbon atom is equal to exactly 12.011 amu.
Answer: False
4.2 Multiple-Choice Questions

1) Which of the following statements about atoms is FALSE?

A) Atoms compose all matter.
B) Atoms are responsible for the sensation of smell.
C) Atoms are the basic building block of nature.
D) An atom is the smallest identifiable unit of an element.
E) All of the above statements are true.

Answer: E

2) Which statement below accurately describes the contributions of Democritus?

A) ancient Greek philosopher who proposed that matter was not continuous
B) created the modern periodic table
C) proposed the modern Atomic Theory
D) discovered the existence of electrons
E) none of the above

Answer: A

3) Which statement below accurately describes the contributions of Dalton?

A) ancient Greek philosopher who proposed that matter was continuous
B) created the modern periodic table
C) proposed the modern Atomic Theory
D) discovered the existence of electrons
E) none of the above

Answer: C
4) Which of the following is not part of Dalton's Atomic Theory?

A) Each element is composed of tiny indestructible particles called atoms.
B) All atoms of a given element have the same mass and other properties that distinguish them from the atoms of other elements.
C) Atoms combine in simple, whole-number ratios to form compounds.
D) Most of the atom's mass and all of its positive charge is contained in a small core called the nucleus.
E) All of the above are part of the atomic theory.

Answer: D

5) Which statement below accurately describes the contributions of Thomson?

A) ancient Greek philosopher who proposed that matter was continuous
B) created the modern periodic table
C) proposed the modern Atomic Theory
D) discovered the existence of electrons
E) none of the above

Answer: D

6) Which of the statements about the discovery of electrons is FALSE?

A) Because atoms are neutral, the existence of a negatively charged particle implied there must be a positively charged component of an atom.
B) Thomson proposed that electrons were small particles held within a positively charged sphere.
C) Rutherford proved the plum-pudding model correct.
D) The negatively charged electron is located outside the nucleus.
E) All of the above statements are true.

Answer: C
7) Which statement below is NOT consistent with the nuclear theory of the atom as proposed by Rutherford?

A) Most of the atom's mass and all of its positive charge is contained in a small core called the nucleus.
B) Electrical charge is a fundamental property of protons and electrons in which like charges repel and opposite charges attract.
C) Most of the volume of the atom is empty space occupied by tiny, negatively charged electrons.
D) There are as many electrons outside the nucleus as there are protons inside the nucleus in a neutral atom.
E) All of the above statements are consistent.

Answer: B

8) Which statement reflects the results of Rutherford's gold foil experiments?

A) Most all of the alpha particles were deflected back in the direction from which they came.
B) Many alpha particles sputtered gold atoms off of the surface of the foil.
C) Many alpha particles were deflected while passing through the foil.
D) Most all of the alpha particles passed directly through the foil.
E) none of the above

Answer: D

9) The atomic mass unit is defined as:

A) the mass of the hydrogen atom containing only one proton.
B) the mass of electrons found in a carbon atom containing six protons and neutrons.
C) 1/12 the mass of a carbon atom containing six protons and six neutrons.
D) 1/14 the mass of a nitrogen atom containing 7 protons and 7 neutrons.
E) none of the above

Answer: C
10) Which of the following statements about the nature of electrical charge is FALSE?

A) Electrical charge is a fundamental property of protons and electrons.
B) Positive and negative electrical charges attract each other.
C) Positive-positive or negative-negative charges repel each other.
D) Positive and negative charges cancel each other so that a proton and electron, when paired, are charge neutral.
E) All of the above statements are true.

Answer: E

11) Which of the following subatomic particles has a mass of $1.67 \times 10^{-27}$ kg?

A) electrons only
B) protons only
C) neutrons only
D) protons and neutrons
E) none of the above

Answer: D

12) Which of the following elements has an atomic number of 4?

A) H
B) C
C) He
D) Be
E) none of the above

Answer: D
13) Which of the following elements has only 12 protons?

A) C  
B) Zn  
C) Mg  
D) O  
E) none of the above 

Answer: C 

14) What is the atomic symbol for silver?

A) S  
B) Ag  
C) Au  
D) Si  
E) none of the above 

Answer: B 

15) What is the atomic symbol for tin?

A) Sn  
B) Ti  
C) Tn  
D) Si  
E) none of the above 

Answer: A
16) What is the correct chemical symbol for mercury?

A) Hm
B) Hy
C) Me
D) My
E) none of the above

Answer: E

17) Which of the following is not a correct name, symbol combination?

A) beryllium, Be
B) magnesium, Mg
C) iron, I
D) manganese, Mn
E) silicon, Si

Answer: C

18) Which of the following is not a correct name, symbol combination?

A) beryllium, Be
B) phosphorus, P
C) iron, Fe
D) manganese, Mg
E) silicon, Si

Answer: D
19) Which of the following is not a correct name, symbol combination?

A) calcium, Ca
B) gold, Au
C) manganese, Mn
D) chromium, Cr
E) potassium, P

Answer: E

20) The names of the elements whose symbols are Si, P, Mn, and S are respectively,

A) silicon, potassium, magnesium, and sulfur.
B) silver, phosphorus, magnesium, and sulfur.
C) silicon, phosphorus, manganese, and sulfur.
D) silicon, phosphorus, magnesium, and sulfur.
E) silicon, potassium, magnesium, and sodium.

Answer: C

21) Metals are located where on the periodic table?

A) left side
B) right side
C) middle
D) zig-zag diagonal line
E) none of the above

Answer: A
22) Nonmetals are located where on the periodic table?

A) left side  
B) right side  
C) middle  
D) zig-zag diagonal line  
E) none of the above

Answer: B

23) Metalloids are located where on the periodic table?

A) left side  
B) right side  
C) middle  
D) zig-zag diagonal line  
E) none of the above

Answer: D

24) Group 1A elements are also called:

A) noble gases.  
B) halogens.  
C) alkaline earth metals.  
D) alkali metals.  
E) none of the above

Answer: D
25) Group 7A elements are also called:

A) noble gases.
B) halogens.
C) alkaline earth metals.
D) alkali metals.
E) none of the above

Answer: B

26) Group 8A elements are also called:

A) noble gases.
B) halogens.
C) alkaline earth metals.
D) alkali metals.
E) none of the above

Answer: A

27) Group 2A elements are also called:

A) noble gases.
B) halogens.
C) alkaline earth metals.
D) alkali metals.
E) none of the above

Answer: C
28) Mg is a member of which family?

A) noble gases  
B) halogens  
C) alkaline earth metals  
D) alkali metals  
E) none of the above

Answer: C

29) Xe is a member of which family?

A) noble gases  
B) halogens  
C) alkaline earth metals  
D) alkali metals  
E) none of the above

Answer: A

30) Cr is a member of which family?

A) noble gases  
B) halogens  
C) alkaline earth metals  
D) alkali metals  
E) none of the above

Answer: E
31) All of the following statements about different elements are true EXCEPT:

A) Barium is an alkaline earth metal.
B) Manganese is a transition metal.
C) Sulfur is considered a metalloid.
D) Krypton is one of the noble gases.
E) Iodine is a halogen.

Answer: C

32) Identify the element that is a nonmetal, a gas, and has an elemental symbol that starts with the letter "A".

A) Ac
B) Ar
C) Au
D) Al
E) none of the above

Answer: B

33) Ions are formed when atoms

A) gain or lose protons
B) gain or lose electrons
C) gain or lose neutrons
D) Each of these results in ion formation
E) None of these results in ion formation

Answer: B
34) When an atom loses an electron, the resulting particle is called

A) a proton
B) an anion
C) a cation
D) an isotope
E) none of the above

Answer: C

35) When an atom gains an electron, the resulting particle is called

A) a proton
B) an anion
C) a cation
D) an isotope
E) none of the above

Answer: B

36) Which of the following statements about ions is INCORRECT?

A) Cations are positive ions and anions are negative ions.
B) Cations are formed when an atom loses electrons.
C) Anions are formed when an atom gains electrons.
D) Cations are formed when an atom gains protons.
E) All statements are correct.

Answer: D
37) What is the correct formula for a potassium ion with 18 electrons?

A) P+
B) K+
C) K-
D) P-
E) none of the above

Answer: B

38) How many electrons are in Br⁻?

A) 4
B) 7
C) 34
D) 36
E) none of the above

Answer: D

39) How many protons and electrons are present in O²⁻?

A) 8 protons and 8 electrons.
B) 10 protons and 8 electrons.
C) 8 protons and 10 electrons.
D) 16 protons and 8 electrons.
E) none of the above

Answer: C
40) What is the charge on the barium ion?

A) 1-
B) 2-
C) 1+
D) 2+
E) none of the above

Answer: D

41) What is the charge on the ion formed by selenium?

A) 1-
B) 2-
C) 1+
D) 2+
E) none of the above

Answer: B

42) What is the charge on the cesium ion?

A) 1-
B) 2-
C) 1+
D) 2+
E) none of the above

Answer: C
43) How many electrons would be in a -2 charged anion of sulfur?

A) 2  
B) 16  
C) 18  
D) 36  
E) none of the above  

Answer: C

44) Isotopes are:

A) atoms of the same element that have different number of neutrons.  
B) atoms of the same element that have different number of protons.  
C) atoms of the same element that have different number of electrons.  
D) atoms of the same element that have the same number of neutrons.  
E) none of the above  

Answer: A

45) The nucleus of an atom consists mainly of

A) neutrons and electrons.  
B) protons and electrons.  
C) protons and neutrons.  
D) protons, neutrons, and electrons  
E) none of the above  

Answer: C
46) How many neutrons are present in Ne-22?

A) 12  
B) 10  
C) 22  
D) 32  
E) none of the above

Answer: A

47) How many neutrons are present in C-14?

A) 14  
B) 12  
C) 6  
D) 8  
E) none of the above

Answer: D

48) What is the mass number of the hydrogen isotope that contains 2 neutrons?

A) 1  
B) 2  
C) 3  
D) 4  
E) none of the above

Answer: C
49) How many protons and neutrons are in Cl-37?

A) 20 protons, 17 neutrons
B) 17 protons, 37 neutrons
C) 17 protons, 20 neutrons
D) 37 protons, 17 neutrons
E) none of the above

Answer: C

50) An atom of a carbon-14 isotope would contain

A) 6 protons, 8 neutrons, and 6 electrons.
B) 8 protons, 6 neutrons, and 8 electrons.
C) 6 protons, 8 neutrons, and 8 electrons.
D) 14 protons, 6 neutrons, and 6 electrons.
E) 20 protons, 6 neutrons, and 20 electrons.

Answer: A

51) An atom that has the same number of neutrons as $^{138}_{56}$Ba is

A) $^{138}_{55}$Cs
B) $^{138}_{56}$Ba
C) $^{137}_{57}$La
D) $^{136}_{54}$Xe
E) none of the above

Answer: D
52) A specific isotope of an element is known to have 15 protons and 16 neutrons. Which symbol would properly represent this isotope?
A) \(^{15}_{31}\text{Ga}\)
B) \(^{31}_{15}\text{P}\)
C) \(^{16}_{15}\text{X}\)
D) \(^{31}_{16}\text{S}\)
E) none of the above

Answer: B

53) A fictional element has two naturally occurring isotopes with the natural abundances shown here:

<table>
<thead>
<tr>
<th>ISOTOPE</th>
<th>ABUNDANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>40.0%</td>
</tr>
<tr>
<td>20</td>
<td>60.0%</td>
</tr>
</tbody>
</table>

Which statement is true for this element?

A) The atomic mass would be less than 18.
B) The atomic mass would be closer to 18 than to 20.
C) The atomic mass would be exactly 19.
D) The atomic mass would be closer to 20 than to 18.
E) The atomic mass would be greater than 20.

Answer: D
54) A fictional element has two isotopes, each making up 50% of the population. Isotope 1 has a mass of 80.0 amu, Isotope 2 has a mass of 85.0 amu. Calculate the atomic mass of the fictional element.

A) 82.5 amu  
B) 42.5 amu  
C) 40 amu  
D) 165 amu  
E) none of the above

Answer: A

55) A fictional element has two isotopes and an atomic mass of 87.08 amu. If the first isotope is 86 amu and the second isotope has a mass of 90 amu. Which isotope has the greatest natural abundance?

A) 86 amu  
B) 90 amu  
C) There are equal amounts.  
D) Not enough information provided.  
E) none of the above

Answer: A

56) Chlorine has two stable isotopes, Cl-35 and Cl-37. If their exact masses are 34.9689 amu and 36.9695 amu, respectively, what is the natural abundance of Cl-35? (The atomic mass of chlorine is 35.45 amu)

A) 75.95%  
B) 24.05%  
C) 50.00%  
D) 35.00%  
E) 37.00%

Answer: A
4.3 Algorithmic Questions

1) What is the charge on an ion that has an atomic number of 27 and contains 26 e⁻?
   A) 1⁺
   B) 1⁻
   C) 2⁻
   D) 2⁺
   E) none of the above

   Answer: A

2) What is the charge on a bromine atom that contains 36 e⁻?
   A) 2⁺
   B) 35⁺
   C) 1⁻
   D) 1⁺
   E) none of the above

   Answer: C

3) How many neutrons are found in Cr-54?
   A) 30
   B) 54
   C) 24
   D) 0
   E) none of the above

   Answer: A
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4) How many protons are found in C-14?

A) 8  
B) 14  
C) 6  
D) 0  
E) none of the above  

Answer: C

5) Given that the molecular mass of beryllium is 9.01 grams, which of the following isotopes would you expect to have the greatest natural abundance?

A) Be-8  
B) Be-9  
C) Be-7  
D) Be-10  
E) none of the above  

Answer: B
5.1 True/False Questions

1) When elements combine to form compounds, their properties only change slightly.
   Answer: False

2) The properties of a compound are an average of the properties of the individual elements.
   Answer: False

3) Life could not exist with just 91 elements if they did not combine to form compounds.
   Answer: True

4) Although some substances we encounter in our routine lives are elements, most occur in the combined state.
   Answer: True

5) The law of constant composition states: All samples of a given compound have the same proportions of their constituent elements.
   Answer: True

6) The fact that water has an oxygen-to-hydrogen mass ratio of 8.0 illustrates the law of conservation of mass.
   Answer: False
7) The subscripts in a chemical formula represent the relative mass of each atom in a chemical compound.
Answer: False

8) The subscripts in a chemical formula do not change for a given compound.
Answer: True

9) Molecular elements do not exist in nature.
Answer: False

10) The element nitrogen normally exists in nature as a diatomic molecule.
Answer: True

11) Carbon dioxide is an example of a molecular compound.
Answer: True

12) The basic unit of an ionic compound is called the formula unit.
Answer: True
13) $\text{SO}_2$ is an ionic compound.
Answer: False

14) Ionic compounds have a net charge of zero.
Answer: True

15) Ionic compounds always contain positive and negative ions.
Answer: True

16) In ionic compounds the net positive charge always equals the net negative charge.
Answer: True

17) The ionic compound that forms between aluminum and oxygen is $\text{AlO}$.
Answer: False

18) The ionic compound that forms between Mg and O is $\text{MgO}$.
Answer: True
19) The correct formula for calcium fluoride is CaF₂.
Answer: False

20) Ionic compounds are usually made up of a metal and a nonmetal.
Answer: True

21) The ionic compound MgO is named manganese oxide.
Answer: False

22) The name of KNO₃ is potassium nitratide.
Answer: False

23) The correct formula for sodium permanganate is NaMgO₄.
Answer: False

24) The proper name for SF₆ is sulfur tetrafluoride.
Answer: False
25) The proper name for the acid HF is hydrofluoric acid.  
Answer: True

26) The proper name for HI is hydroiodic acid.  
Answer: True

27) The correct name for HNO₃ is hydronitric acid.  
Answer: False

28) The correct name for H₂SO₃ is sulfurous acid.  
Answer: True

5.2 Multiple-Choice Questions

1) When elements combine to form compounds,

A) their properties are an average of all elements in the compound.  
B) their properties change completely.  
C) their properties do not change.  
D) their properties are completely random.  
E) none of the above

Answer: B
2) The first chemist to formally state the law of constant composition was ________.

A) Dalton  
B) Mendeleev  
C) Rutherford  
D) Proust  
E) none of the above

Answer: D

3) The law of constant composition states:

A) Matter cannot be either created or destroyed in a chemical reaction.  
B) The nucleus is a dense region of positive charge that always contains protons and neutrons.  
C) All samples of a given compound have the same proportions of their constituent elements.  
D) All atoms of a given element have a constant composition and are different than atoms of any other element.  
E) none of the above

Answer: C

4) The oxygen-to-hydrogen mass ratio of water is always 8.0 is an example of what fundamental law?

A) Law of Constant Composition  
B) Law of Constant Mass Ratio  
C) Law of Conservation of Mass  
D) Law of Constant Whole Number Ratio  
E) none of the above

Answer: A
5) What is the oxygen-to-hydrogen mass ratio for H₂O₂?

A) 0.125  
B) 4  
C) 8  
D) 16  
E) none of the above

Answer: D

6) What is the oxygen-to-sulfur mass ratio of sulfur dioxide?

A) 0.5  
B) 1.0  
C) 2.0  
D) 16  
E) none of the above

Answer: B

7) Which of the following statements about chemical formulas is FALSE?

A) The subscripts represent the relative number each type of atom in the compound.  
B) The subscripts represent the relative mass of each type of atom in the compound.  
C) The subscripts do not change for a given compound.  
D) Different compounds made of the same elements have different subscripts.  
E) All of the statements are true.

Answer: B
8) How many total atoms are in the formula $\text{Al}_2(\text{CO}_3)_3$?

A) 8  
B) 9  
C) 12  
D) 14  
E) none of the above

Answer: D

9) How many carbon atoms are in the formula $\text{Al}_2(\text{CO}_3)_3$?

A) 3  
B) 9  
C) 1  
D) 6  
E) none of the above

Answer: A

10) How many oxygen atoms are in the formula $\text{Al}_2(\text{CO}_3)_3$?

A) 3  
B) 9  
C) 1  
D) 6  
E) none of the above

Answer: B
11) How many of each type of atoms are there in the formula NH₄C₂H₃O₂?

A) N = 4, H = 7, C = 2, O = 2  
B) N = 1, H = 4, C = 2, O = 2  
C) N = 1, H = 3, C = 2, O = 2  
D) N = 1, H = 7, C = 2, O = 2  
E) none of the above

Answer: D

12) How many of each type of atom are there in the formula Ca₃(PO₄)₂?

A) Ca = 3, P = 1, O = 4  
B) Ca = 3, P = 2, O = 4  
C) Ca = 3, P = 2, O = 8  
D) Ca = 3, P = 1, O = 8  
E) none of the above

Answer: C

13) How many of each type of atom are there in the formula (NH₄)₂HPO₄?

A) N = 2, H = 9, P = 1, O = 4  
B) N = 1, H = 5, P = 1, O = 4  
C) N = 2, H = 5, P = 1, O = 4  
D) N = 2, H = 8, P = 1, O = 4  
E) none of the above

Answer: A
14) What is the correct formula for a compound that has three oxygen atoms and one sulfur atom?

A) O₃S
B) SO₃
C) 3OS
D) SO₃
E) none of the above

Answer: B

15) What is the correct formula of a compound that has ten oxygen atoms and four phosphorus atoms?

A) O₁₀P₄
B) 10OP₄
C) 4PO₁₀
D) P₄O₁₀
E) none of the above

Answer: D

16) Carbon is considered which of the following?

A) atomic element
B) molecular element
C) molecular compound
D) ionic compound
E) none of the above

Answer: A
17) Which among the following elements does not exist as a diatomic molecule in nature?

A) hydrogen  
B) nitrogen  
C) fluorine  
D) neon  
E) none of the above

Answer: D

18) Carbon monoxide is considered which of the following?

A) atomic element  
B) molecular element  
C) molecular compound  
D) ionic compound  
E) none of the above

Answer: C

19) Fluorine is considered which of the following?

A) atomic element  
B) molecular element  
C) molecular compound  
D) ionic compound  
E) none of the above

Answer: B
20) Ammonium fluoride is considered which of the following?

A) atomic element  
B) molecular element  
C) molecular compound  
D) ionic compound  
E) none of the above

Answer: D

21) Which of the following species is a molecular element?

A) neon  
B) sulfur  
C) chlorine  
D) carbon dioxide  
E) none of the above

Answer: C

22) Which of the following is a molecular compound?

A) barium sulfide  
B) calcium acetate  
C) potassium hydroxide  
D) nitrogen monoxide  
E) none of the above

Answer: D
23) What is the formula for an ionic compound made of barium and nitrogen?

A) Ba$_3$N$_2$
B) Ba$_2$N$_3$
C) BaN
D) Ba$_2$N$_4$
E) none of the above

Answer: A

24) What is the formula for an ionic compound made of magnesium and sulfur?

A) MgS
B) MgS$_2$
C) Mg$_2$S
D) Mg$_2$S$_3$
E) none of the above

Answer: A

25) What is the formula for an ionic compound made of carbon and oxygen?

A) CO$_2$
B) C$_2$O
C) CO
D) CO$_3$
E) Carbon and oxygen do not form an ionic compound.

Answer: E
26) What is the formula for an ionic compound made of aluminum and oxygen?

A) AlO2  
B) Al2O3  
C) Al3O2  
D) AlO  
E) none of the above

Answer: B

27) What is the name of the ionic compound made of beryllium and chlorine?

A) beryllium(II) chloride  
B) beryllium dichloride  
C) beryllium chloride  
D) monoberyllium dichloride  
E) none of the above

Answer: C

28) What is the name of the compound made from lithium and oxygen?

A) lithium dioxide  
B) lithium(I) oxide  
C) oxygen lithide  
D) lithium oxide  
E) none of the above

Answer: D
29) What is the name of CoS?

A) cobalt(II) sulfide  
B) cobalt sulfide  
C) cobalt monosulfide  
D) cobaltous sulfur  
E) none of the above

Answer: A

30) What is the name of Ca(NO_3)_2?

A) calcium dinitrite  
B) calcium nitrate  
C) calcium nitride  
D) calcium nitrite  
E) none of the above

Answer: B

31) Choose the pair of names and formulas that do not match.

A) magnesium nitrite: Mg(NO_2)_3  
B) calcium carbonate: CaCO_3  
C) aluminum sulfate: Al_2(SO_4)_3  
D) sodium hydrogen carbonate: NaHCO_3  
E) potassium hydroxide: KOH

Answer: A
32) Choose the pair of names and formulas that do not match.

A) strontium carbonate: SrCO₃
B) ammonium cyanide: NH₄CN
C) potassium acetate: KC₂H₃O₂
D) calcium nitrate: Ca(NO₃)₂
E) lithium sulfate: LiSO₄

Answer: E

33) What is the name of the compound whose formula is Na₂O?

A) sodium monoxide
B) disodium oxide
C) disodium monoxide
D) sodium oxide
E) none of the above

Answer: D

34) What is the formula for the acetate polyatomic ion?

A) C₃H₂O₃⁻
B) C₂H₃O₂⁻
C) C₂H₃O₂⁻
D) C₂H₃O⁻
E) none of the above

Answer: C
35) What is the correct formula for potassium dichromate?

A) K(CrO₄)₂
B) KCr₂O₇
C) K₂CrO₄
D) K₂Cr₂O₇
E) none of the above

Answer: D

36) What is the correct formula for ammonium hydrogen sulfate?

A) NH₄HSO₄
B) (NH₄)₂HSO₄
C) (NH₄)₂SO₄
D) Am₂HSO₄
E) none of the above

Answer: A

37) The formula for potassium chlorate is KClO₃. The formula for magnesium chloride is MgCl₂. What is the formula for magnesium chlorate?

A) MgClO₃
B) Mg₂ClO₃
C) Mg(ClO₃)₂
D) Mg₂(ClO₃)₃
E) none of the above

Answer: C
38) What is the correct formula for the hypochlorite polyatomic ion?

A) ClO^−
B) ClO_2^−
C) ClO_3^−
D) ClO_4^−
E) none of the above

Answer: A

39) What is the name of the molecular compound SF$_5$?

A) sulfur hexafluoride
B) sulfur heptafluoride
C) monosulfur tetrafluoride
D) sulfur pentafluoride
E) none of the above

Answer: D

40) What is the name of the molecular compound SO$_3$?

A) sulfur oxide
B) sulfur(IV) oxide
C) sulfur trioxide
D) sulfur tetraoxide
E) none of the above

Answer: C
41) What is correct name of the compound whose formula is N₂O₄?

A) nitrogen dioxide  
B) nitrogen tetroxide  
C) dinitrogen oxide  
D) dinitrogen tetroxide  
E) none of the above

Answer: D

42) What is correct name of the compound whose formula is BF₃?

A) boron trifluoride  
B) boron fluoride  
C) monoboron trifluorine  
D) boron(III) fluoride  
E) none of the above

Answer: A

43) What would the formula of diiodine pentasulfide be?

A) I₅S₂  
B) I₂S₅  
C) I₄S₉  
D) I₂S₇  
E) none of the above

Answer: B
44) What is the correct formula for the molecular compound heptaphosphorus octafluoride?

A) $P_5F_8$
B) $P_7F_6$
C) $P_6F_7$
D) $P_7F_8$
E) none of the above

Answer: D

45) What is the proper name for HBr?

A) hydrobromous acid
B) hydrous bromic acid
C) hydrobromic acid
D) bromous acid
E) none of the above

Answer: C

46) What is the name of HI?

A) hydroiodous acid
B) hydroiodic acid
C) iodic acid
D) iodous acid
E) none of the above

Answer: B
47) What is the name of HIO₃?

A) iodic acid
B) hydroiodic acid
C) hydroiodous acid
D) iodous acid
E) none of the above

Answer: A

48) What is the name of HNO₂?

A) Nitric acid
B) Nitrous acid
C) hydronitrous acid
D) hydronitric acid
E) none of the above

Answer: B

49) A certain oxyacid is derived from the oxyanion \( \text{SO}_3^{2-} \). The formula for the oxyacid is

A) \( \text{H}_2\text{SO}_4 \)
B) \( \text{HSO}_3 \)
C) \( \text{H}_2\text{SO}_3 \)
D) \( \text{H}_3\text{SO}_3 \)
E) none of the above

Answer: C
50) What is the formula mass of sulfurous acid?

A) 82.08 amu  
B) 98.08 amu  
C) 83.09 amu  
D) 66.08 amu  
E) none of the above

Answer: A


51) What is the formula mass for potassium nitrate?

A) 92.99 amu  
B) 117.11 amu  
C) 85.11 amu  
D) 101.10 amu  
E) none of the above

Answer: D


52) What is the formula mass for diboron tetrachloride?

A) 127.98 amu  
B) 198.89 amu  
C) 234.34 amu  
D) 163.43 amu  
E) none of the above

Answer: D
53) Which of the following has the largest formula mass?

A) CO₂
B) SO₂
C) NO₂
D) SiO₂
E) H₂O

Answer: B

54) Which of the following compounds have the smallest formula mass?

A) CO₂
B) SO₂
C) NO₂
D) SiO₂
E) H₂O

Answer: E

55) What is the formula mass of copper(II) fluoride?

A) 101.55
B) 146.10
C) 90.00
D) 165.10
E) none of the above

Answer: A
5.3 Algorithmic Questions

1) What is the mass ratio of Na to S in sodium sulfide?

A) 7.17  
B) 55.06  
C) 0.717  
D) 1.43  
E) none of the above

Answer: D

2) If the mass ratio of K to F in a compound is 2.06:1, how many grams of F are needed to react with 101g of K?

A) 0.0204  
B) 49.0  
C) 4.900  
D) 2.04  
E) none of the above

Answer: B

3) How many O atoms are in ammonium acetate?

A) 5  
B) 2  
C) 1  
D) 3  
E) none of the above

Answer: B
4) How many O atoms are present in sodium hypochlorite?

A) 1  
B) 6  
C) 2  
D) 4  
E) none of the above

Answer: A

5) What is the formula mass of magnesium sulfide?

A) 154.97  
B) 59.76  
C) 56.41  
D) 84.07  
E) none of the above

Answer: C
6.1 True/False Questions

1) The chemical formula clearly indicates the relationship between the mass of each element in the formula.
   Answer: False

2) Mass is used as a method of counting atoms.
   Answer: True

3) The numerical value of the mole is defined as being equal to the number of atoms in exactly 12 grams of pure carbon-12.
   Answer: True

4) The mole has a value of $6.023 \times 10^{23}$. 
   Answer: False

5) Avogadro's Number is $6.022 \times 10^{23}$.
   Answer: True

6) One mole of nitrogen gas contains $(2) \times (6.022 \times 10^{23})$ nitrogen atoms.
   Answer: True
7) One mole of copper atoms is $6.022 \times 10^{23}$ copper atoms.  
Answer: True

8) One mole of chlorine gas has a mass of 35.45 grams.  
Answer: False

9) Two moles of cobalt atoms have a mass of 117.87 grams.  
Answer: True

10) Six grams of carbon contains $3.008 \times 10^{23}$ atoms.  
Answer: True

11) The mass of 2.0 moles of H$_2$O is greater than the mass of 1.0 mole of CO$_2$.  
Answer: False

12) One mole of CO$_2$ gas contains 1 mole of carbon atoms and 2 moles of oxygen atoms.  
Answer: True
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13) One mole of water contains 16 grams of oxygen atoms.
   Answer: True

14) One mole of water contains \(6.022 \times 10^{23}\) hydrogen atoms.
   Answer: False

15) The chemical formula \(\text{CuBr}_2\) indicates that this compound is composed of 1 gram of copper and 2 grams of bromine.
   Answer: False

16) There are 6 grams of carbon in 22 grams of carbon dioxide.
   Answer: True

17) The molar mass of a compound serves as a conversion factor between grams and moles.
   Answer: True

18) Water is 11.2% hydrogen by mass.
   Answer: True
19) The correct formula for calculating mass percent of X in compound XY is:

\[
\text{Mass % X} = \frac{\text{Mass of X in a sample of the compound}}{\text{Mass of Y in a sample of the compound}}
\]

Answer: False

20) \(C_2H_3O_2\) could be an empirical formula.
Answer: True

21) \(C_2H_6O_3\) could be an empirical formula.
Answer: True

22) \(C_2H_6O_4\) could be an empirical formula.
Answer: False

23) An empirical formula gives the specific number of each type of atom in a molecule.
Answer: False

24) An empirical formula gives the smallest whole number ratio of each type of atom in a molecule.
Answer: True
25) The empirical formula for $\text{C}_6\text{H}_6$ is $\text{C}_3\text{H}_3$.
Answer: False

26) The molecular formula is equal to the empirical formula multiplied by a whole number integer.
Answer: True

27) The empirical formula mass is 18.0 and the molecular formula mass is 90, therefore $n = 5$.
Answer: True

28) The empirical formula mass must be 25.0 if the molecular formula mass is 250 and $n = 5$.
Answer: False

6.2 Multiple-Choice Questions

1) What is the correct value for Avogadro's number?

   A) $6.022 \times 10^{23}$
   B) $6.022 \times 10^{23}$
   C) $6.023 \times 10^{22}$
   D) $6.022 \times 10^{2.3}$
   E) none of the above

Answer: A
2) Which of the following statements about the mole is FALSE?

A) The size of a mole of atoms has a reasonable mass.
B) A mole of an element corresponds to one Avogadro number of atoms.
C) One mole of an element has a mass equal to its atomic mass expressed in grams.
D) One mole of water contains 1/2 mole of oxygen atoms.
E) none of the above

Answer: D

3) How many atoms are in 5.80 moles of He?

A) $6.02 \times 10^{23}$
B) $1.03 \times 10^{23}$
C) 4.00
D) $3.49 \times 10^{24}$
E) none of the above

Answer: D

4) How many atoms are in 1.50 moles of fluorine gas?

A) $6.022 \times 10^{23}$
B) $9.03 \times 10^{23}$
C) 18.98
D) $1.81 \times 10^{24}$
E) none of the above

Answer: D
5) How many moles of Cu are in $1.48 \times 10^{25}$ Cu atoms?

A) 0.0408  
B) 24.6  
C) $1.54 \times 10^{25}$  
D) $6.022 \times 10^{23}$  
E) none of the above

Answer: B

6) How many moles of Pb are in $4.71 \times 10^{21}$ Pb atoms?

A) 0.00782  
B) $2.84 \times 10^{45}$  
C) 207.2  
D) $6.022 \times 10^{23}$  
E) none of the above

Answer: A

7) One mole of boron has a mass of ________ g.

A) 9.012  
B) $6.022 \times 10^{23}$  
C) 5  
D) 10.811  
E) none of the above

Answer: D
8) One mole of oxygen gas has a mass of ________ g.

A) 16.0  
B) 32.0  
C) \(6.022 \times 10^{23}\)  
D) 8  
E) none of the above  

Answer: B

9) What is the mass in grams of 5.40 moles of lithium?

A) 6.94 
B) 37.5 
C) 1.29 
D) \(3.25 \times 10^{24}\) 
E) none of the above 

Answer: B

10) What is mass of 0.560 moles of chlorine gas?

A) 19.9 
B) 63.3 
C) 127 
D) 39.7  
E) none of the above 

Answer: D
11) You have 10.0 g each of Na, C, Pb, Cu and Ne. Which contains the largest number of moles?

A) Na
B) C
C) Pb
D) Cu
E) Ne

Answer: B

12) You have 10.0 g each of Na, C, Pb, Cu and Ne. Which contains the smallest number of moles?

A) Na
B) C
C) Pb
D) Cu
E) Ne

Answer: C

13) How many moles of iron are contained in 1.75 kg of iron?

A) $3.13 \times 10^{-2}$
B) $3.13 \times 10^{-4}$
C) 31.3
D) $3.13 \times 10^4$
E) none of the above

Answer: C
14) How many moles are there in 17.5 grams of sodium?

A) 22.99  
B) 1.05 \times 10^{25}  
C) 0.761  
D) 1.31  
E) none of the above

Answer: C

15) How many moles are there in 82.5 grams of iron?

A) 4.97 \times 10^{25}  
B) 55.85  
C) 0.677  
D) 1.48  
E) none of the above

Answer: D

16) How many moles of bromine gas are in 37.7 grams?

A) 0.236  
B) 0.472  
C) 3.01 \times 10^{3}  
D) 79.9  
E) none of the above

Answer: A
17) How many atoms are in 15.6 grams of silicon?

A) \(2.64 \times 10^{26}\)
B) \(3.34 \times 10^{23}\)
C) 0.555
D) 438
E) none of the above

Answer: B

18) How many hydrogen atoms are in 35.0 grams of hydrogen gas?

A) \(4.25 \times 10^{25}\)
B) \(2.09 \times 10^{25}\)
C) \(2.12 \times 10^{25}\)
D) \(1.05 \times 10^{25}\)
E) none of the above

Answer: D

19) Which of the following molecules contain \(9.02 \times 10^{23}\) atoms?

A) 4.00 g H\(_2\)
B) 9.00 g H\(_2\)O
C) 28.0 g N\(_2\)
D) 32.0 g O\(_2\)
E) none of the above

Answer: B
20) What is the mass of $3.09 \times 10^{24}$ atoms of sulfur in grams?

A) $9.64 \times 10^{22}$  
B) $9.91 \times 10^{25}$  
C) 165  
D) 0.160  
E) none of the above

Answer: C

21) What is the mass of $1.56 \times 10^{21}$ atoms of magnesium in grams?

A) $4.72 \times 10^{-5}$  
B) 0.0630  
C) 0.142  
D) $1.07 \times 10^{-4}$  
E) none of the above

Answer: B

22) The mass of one mole of carbon dioxide is _______ g.

A) 28.01  
B) 384.4  
C) 32.00  
D) 44.01  
E) none of the above

Answer: D
23) How many molecules of sulfur trioxide are in 78.0 grams?

A) $5.87 \times 10^{23}$
B) $7.33 \times 10^{23}$
C) $3.76 \times 10^{27}$
D) 0.974
E) none of the above

Answer: A

24) How many molecules of nitrogen monoxide are in a 22.5 gram sample?

A) $5.86 \times 10^{23}$
B) $7.33 \times 10^{23}$
C) $4.51 \times 10^{23}$
D) $4.06 \times 10^{23}$
E) none of the above

Answer: C

25) In comparing 1 mole of carbon atoms to one mole of magnesium atoms, which statement is true?

A) The mass of 1 mole of carbon is greater than the mass of 1 mole of magnesium.
B) The mass of 1 mole of magnesium is greater than the mass of 1 mole of carbon.
C) The mass of 1 mole of carbon is the same as the mass of 1 mole of magnesium.
D) There are more atoms in 1 mole of magnesium than in 1 mole of carbon.
E) none of the above

Answer: B
26) One mole of \((\text{NH}_4)_2\text{HPO}_4\) contains how many moles of hydrogen atoms?

A) 4
B) 2
C) 8
D) 9
E) none of the above

Answer: D

27) One mole of ammonium nitrate contains:

A) 3 moles of hydrogen.
B) 2 moles of oxygen.
C) 2 moles of nitrogen.
D) 1 mole of nitrogen.
E) none of the above

Answer: C

28) One mole of ammonium nitrite contains:

A) 2 moles of nitrogen atoms
B) 4 moles of hydrogen atoms
C) 2 moles of oxygen atoms
D) All of A, B, and C
E) None of A, B, and C

Answer: D
29) One mole of potassium sulfate contains:

A) 4 moles of oxygen.
B) 2 moles of sulfur.
C) 1 mole of potassium.
D) 3 moles of potassium.
E) none of the above

Answer: A

30) Calculate the molar mass of ammonium carbonate.

A) 78.05 g/mol
B) 88.05 g/mol
C) 96.09 g/mol
D) 112.09 g/mol
E) none of the above

Answer: C

31) Calculate the molar mass of calcium nitrate.

A) 136.03 g/mol
B) 102.09 g/mol
C) 132.10 g/mol
D) 164.10 g/mol
E) none of the above

Answer: D
32) What is the molar mass of aluminum sulfate?

A) 123.0 g/mol  
B) 278.0 g/mol  
C) 306.2 g/mol  
D) 315.2 g/mol  
E) 342.2 g/mol

Answer: E

33) How many moles of carbon are in 3.5 moles of calcium carbonate?

A) 10.5  
B) 3.5  
C) 7  
D) 100.09  
E) none of the above

Answer: B

34) How many moles of fluorine are in 3.2 moles of xenon hexafluoride?

A) 22.4  
B) 12.8  
C) 19.2  
D) 16  
E) none of the above

Answer: C
35) If a sample of carbon dioxide contains 3.8 moles of oxygen atoms, how many moles of carbon dioxide are in the sample?

A) 1.9
B) 3.8
C) 7.6
D) 11.4
E) none of the above

Answer: A

36) A 15.5 gram sample of diphosphorous pentoxide contains how many grams of phosphorous?

A) 3.38
B) 1.69
C) 6.76
D) 13.5
E) none of the above

Answer: C

37) A 42.7 gram sample of potassium nitrate contains how many grams of potassium?

A) 39.1
B) 16.5
C) 21.4
D) 8.54
E) none of the above

Answer: B
38) An iron ore sample is found to be 35.00% Fe by mass. How many grams of ore is needed to obtain 454.0 grams of Fe?

A) 1297
B) 158.9
C) 295.1
D) 350.0
E) none of the above

Answer: A

39) A 500. gram iron ore sample was determined to contain 242 grams of iron. What is the mass percent of iron in the ore?

A) 93.7
B) 48.4
C) 51.6
D) 32.6
E) none of the above

Answer: B

40) Bauxite is an ore that contains the element aluminum. If you obtained 108 grams of aluminum from an ore sample that initially weighed 204 grams, what is the mass percent of aluminum in this bauxite ore?

A) 52.9
B) 15.6
C) 0.53
D) 47.1
E) none of the above

Answer: A
41) What is the mass percent of hydrogen in water?

A) 33.3  
B) 88.8  
C) 5.60  
D) 11.2  
E) none of the above 

Answer: D

42) What is the mass percent of chlorine in hydrochloric acid?

A) 2.8  
B) 35.5  
C) 97.2  
D) 70.1  
E) none of the above 

Answer: C

43) What is the mass percent of carbon in oxalic acid, \( \text{H}_2\text{C}_2\text{O}_4 \) ?

A) 2.24  
B) 13.3  
C) 26.7  
D) 34.5  
E) none of the above 

Answer: C
44) Which of the following statements about empirical formulas is incorrect?

A) An empirical formula represents a molecule.
B) An empirical formula gives the smallest whole number ratio of each type of atom in a molecule.
C) An empirical formula must be multiplied by an integer to obtain the molecular formula.
D) The molecular formula can be the same as the empirical formula in some situations.
E) All statements are correct.

Answer: A

45) The empirical formula of a compound:

A) describes the mass relationships in a molecule.
B) is the same as the molecular formula.
C) indicates the structure of the molecule.
D) indicates the simplest ratio of atoms in the compound.
E) is none of the above

Answer: D

46) The simplest formula for hydrogen peroxide is HO. To determine its molecular formula, it is necessary to know

A) the properties of hydrogen peroxide.
B) the density of hydrogen peroxide.
C) the molar mass of hydrogen peroxide.
D) the number of moles of hydrogen peroxide in 1.00 g of the substance.
E) none of the above

Answer: C
47) The chemical formula CHO can be classified as:

A) not enough information
B) molecular only.
C) empirical only.
D) empirical, possibly molecular.
E) none of the above

Answer: D

48) An iron chloride compound contains 55.85 grams of iron and 106.5 grams of chlorine. What is the most likely empirical formula for this compound?

A) FeCl
B) FeCl₂
C) Fe₂Cl
D) FeCl₃
E) Fe₃Cl

Answer: D

49) What is the value of n when the empirical formula is C₃H₅ and the molecular mass is 205.4 g/mol?

A) 0.02
B) 5
C) 10
D) 140
E) none of the above

Answer: B
50) An estrogen compound with the empirical formula $\text{C}_{12}\text{H}_{17}\text{O}_2$ has a molecular mass of 386.6 g/mol. What is the value of $n$ necessary to find the molecular formula?

A) 0.2  
B) 1  
C) 2  
D) 20  
E) none of the above

Answer: C

51) Determine the empirical formula of a compound containing 60.3% magnesium and 39.7% oxygen.

A) $\text{MgO}$  
B) $\text{MgO}_2$  
C) $\text{Mg}_2\text{O}_3$  
D) $\text{Mg}_2\text{O}$  
E) none of the above

Answer: A

52) Determine the empirical formula of a compound containing 83% potassium and 17.0% oxygen.

A) $\text{K}_0$  
B) $\text{KO}_2$  
C) $\text{K}_2\text{O}_3$  
D) $\text{K}_2\text{O}$  
E) none of the above

Answer: D
53) Vitamin C is known chemically by the name ascorbic acid. Determine the empirical formula of ascorbic acid if it is composed of 40.92% carbon, 4.58% hydrogen, and 54.50% oxygen.

A) CHO  
B) CH2O  
C) C2H3O2  
D) C3H4O3  
E) none of the above

Answer: D

54) What is the molecular formula of a compound given the molar mass of the compound is 186.5 gram and the empirical formula is C2H7?

A) C4H14  
B) C3H21  
C) C2H7  
D) C2H14  
E) none of the above

Answer: E

55) What would the empirical formula be for the molecular compound C6H9O4?

A) C2H3O2  
B) CH3O2  
C) C3H6O2  
D) C3H9O4  
E) none of the above

Answer: E
56) A compound has a molar mass of 180.15 g/mol. Given the following percent composition, calculate the molecular formula: 40% C, 6.7% H, 53.3% O

A) CH₃O₂  
B) CH₂O  
C) C₃H₆O₃  
D) C₆H₁₂O₆  
E) none of the above

Answer: D

57) An unknown acid has a molar mass of 60.05 g/mol. Given the following percent composition, what is the molecular formula? 40% C, 6.7% H, 53.3% O

A) C₃H₄O₃  
B) CH₂O  
C) C₂H₄O₂  
D) C₆H₁₂O₆  
E) none of the above

Answer: C

6.3 Algorithmic Questions

1) Bananas cost 33¢ per pound. If you spent $1.20, how many pounds of bananas did you purchase?

A) 6.3  
B) 4.0  
C) 0.275  
D) 3.01  
E) none of the above

Answer: A
2) How many atoms are present in 4.5 moles?

A) $3.7 \times 10^{23}$  
B) $3.7 \times 10^{-25}$  
C) $2.7 \times 10^{24}$  
D) $6.02 \times 10^{23}$  
E) none of the above

Answer: C

3) If you have $1.81 \times 10^{24}$ atoms of copper, how many moles of copper do you have?

A) 0.330  
B) 3.01  
C) 0.750  
D) 2.00  
E) none of the above

Answer: B

4) What is the mass of $1.51 \times 10^{24}$ sulfur atoms?

A) 80.2  
B) 12.8  
C) 61.3  
D) 32.07  
E) none of the above

Answer: A
5) How many moles of potassium are in 156.4 g?

A) 39.10  
B) 4.000  
C) 0.2500  
D) 5.050  
E) none of the above

Answer: B

6) How many atoms of lithium are in 12.5 g?

A) \(1.42 \times 10^{24}\)  
B) \(1.80 \times 10^{24}\)  
C) \(1.08 \times 10^{24}\)  
D) \(2.31 \times 10^{24}\)  
E) none of the above

Answer: C

7) How many moles of oxygen are in 1.10 moles of \(\text{NaClO}_4\)?

A) 1.10  
B) 0.275  
C) 8.10  
D) 4.40  
E) none of the above

Answer: D
8) What is the mass percent of Fe in iron(II) chloride?

A) 21.1  
B) 61.2  
C) 44.1  
D) 83.2  
E) none of the above

Answer: C

9) What is the mass percent of oxygen in calcium oxide?

A) 39.7  
B) 44.4  
C) 17.0  
D) 25.8  
E) none of the above

Answer: B

10) Given that sodium chloride is 39.0% sodium by mass, how many grams of sodium chloride are needed to have 950 mg of Na present?

A) 2.43  
B) 0.371  
C) 2,430  
D) 37.1  
E) none of the above

Answer: A