Chapter 2—Chemical Formulas and Composition Stoichiometry

MULTIPLE CHOICE

1. There are two different common crystalline forms of carbon—diamond and graphite. A less common form called fullerene, C_{60}, also exists. Different forms of the same element in the same physical state are called:
   a. isotopes.
   b. isomers.
   c. alloforms.
   d. allotropes.
   e. structural formulas.

   ANS: D
   OBJ: Define allotrope.
   TOP: Chemical Formulas

2. How many atoms are in a sulfuric acid molecule?
   a. 1
   b. 7
   c. 5
   d. 6
   e. 8

   ANS: B
   OBJ: Know the chemical formulae of common acids.
   TOP: Chemical Formulas

3. If a sample of butane, C_4H_{10}, contains a total of 8.0×10^3 atoms of carbon, how many molecules of butane are in the sample?
   a. 6.0×10^3
   b. 3.0×10^3
   c. 8.0×10^3
   d. 1.1×10^4
   e. 2.0×10^3

   ANS: E
   OBJ: Understand the relationship between molecular formula and the number of atoms of a specific type contained in a single compound. | Convert the number of atoms in a substance to the number of molecules in a substance.
   TOP: Chemical Formulas

4. Name the molecular compound, HNO_3.
   a. ammonia
   b. nitric acid
   c. nitrous acid
   d. nitric oxide
   e. methane

   ANS: B
   OBJ: Know the names and chemical formulae of common acids.
   TOP: Chemical Formulas

5. Name the molecular compound, SO_3.
   a. sulfur oxide
   b. sulfurous acid
   c. sulfur trioxide
   d. sulfuric acid
   e. none of these

   ANS: C
   OBJ: Translate the chemical formula of a binary molecule into a name.
   TOP: Chemical Formulas

6. Which formula / name pair does not match?
   a. HNO_3 / nitric acid, used to produce explosives
   b. CH_3OH / methyl alcohol, wood alcohol
   c. CH_3CH_2OH / ethyl alcohol, alcohol in wine
   d. $CHCl_3$ / acetic acid, found in vinegar
   e. $CH_3CH_2OCH_2CH_3$ / diethyl ether, an anesthetic

   ANS: D
   OBJ: Know the names and chemical formulae of common acids. | Recognize the names and chemical formulae of common organic compounds.
   TOP: Chemical Formulas

7. Name the molecular compound, CH_3COCH_3.
   a. acetone
   b. ethanol
   c. diethyl ether
   d. propane
   e. ethyl alcohol

   ANS: A
   OBJ: Know the names and chemical formulae of common organic compounds.
   TOP: Chemical Formulas

8. What is the molecular formula for ethanol?
   a. CH_3COOH
   b. CH_3COCH_3
   c. $CH_3CH_2OCH_2CH_3$
   d. $CH_3CH_2CO_2H$
   e. CH_3CH_2OH

   ANS: E
   OBJ: Know the names and chemical formulae of common organic compounds.
   TOP: Chemical Formulas

9. Butane, a highly combustible hydrocarbon found in disposable lighters, has the chemical formula:
   a. CO_2
   b. C_4H_8
   c. C_4H_{10}
   d. C_3H_8
   e. CH_3OCH_3

ANS: C
OBJ: Know the names and chemical formulae of common organic compounds. | Translate the chemical formula of a binary molecule into a name.
TOP: Chemical Formulas

10. What is the molecular formula for hydrogen chloride?
    a. HCl
    b. HClO
    c. $HClO_2$
    d. $HClO_3$
    e. $HClO_4$

    ANS: A
    OBJ: Know the names and chemical formulae of common acids.
    TOP: Chemical Formulas

11. A compound contains only calcium and fluorine. A sample of the compound is determined to contain 2.00 g of calcium and 1.90 g of fluorine. According to the Law of Definite Proportions, how much calcium should another sample of this compound contain if it contains 2.85 g of fluorine?
    a. 2.71 g
    b. 4.00 g
    c. 3.00 g
    d. 4.50 g
    e. 6.00 g

    ANS: C
    OBJ: Apply the Law of Definite Proportions.
    TOP: Chemical Formulas

12. A compound contains only magnesium and oxygen. A sample of the compound is determined to contain 3.50 g of magnesium and 2.30 g of oxygen. According to the Law of Definite Proportions, how much magnesium should another sample of this compound contain if it contains 6.91 g of oxygen?
    a. 1.16 g
    b. 10.5 g
    c. 4.54 g
    d. 55.5 g
    e. 0.858 g

    ANS: B
    OBJ: Apply the Law of Definite Proportions.
    TOP: Chemical Formulas

13. Which of the following is **not** the name of a cation?
    a. sodium
    b. iron (III)
    c. magnesium
    d. sulfide
    e. ammonium

    ANS: D
    OBJ: Understand how to name monatomic anions and cations. | Know the names and charges of polyatomic ions.
    TOP: Ions and Ionic Compounds

14. Which of the following statements is **incorrect**?
    a. Potassium chloride forms molecules that consist of one K^+ ion and one Cl^- ion.
    b. Ions that possess a positive charge are called cations.
    c. Polyatomic ions are groups of atoms that have an electric charge.
    d. It is acceptable to use formula unit to refer to either an ionic compound or a molecular compound.
    e. Ions that possess a negative charge are called anions.

    ANS: A
    OBJ: Distinguish between properties that define a substance as ionic or molecular.
    TOP: Ions and Ionic Compounds

15. What is the correct classification for OCl^-?
    a. polyatomic molecule
    b. monatomic cation
    c. polyatomic cation
    d. polyatomic anion
    e. monatomic anion

    ANS: D
    OBJ: Classify a species as a monatomic ion, polyatomic ion, or molecule.
    TOP: Ions and Ionic Compounds

16. What is the correct formula for the carbonate ion?
    a. CH_3COO^-
    b. Cl^-
    c. CO_2^{2-}
    d. CO_3^{2-}
    e. $(COO^-)_2$

    ANS: D
    OBJ: Know the names, chemical formulae, and charges of common polyatomic ions.
    TOP: Ions and Ionic Compounds

17. Each response below lists an ion by name and by chemical symbol or formula. Also each ion is classified as monatomic or polyatomic and as a cation or anion. Which response contains an **error**?
    a. hydroxide / OH^- / monatomic / anion
    b. carbonate / CO_3^{2-} / polyatomic / anion
    c. ammonium / NH_4^+ / polyatomic / cation
    d. magnesium / Mg^{2+} / monatomic / cation
    e. sulfite / SO_3^{2-} / polyatomic / anion

    ANS: A
    OBJ: Know the names, chemical formulae, and charges of monatomic ions and common polyatomic ions.
    TOP: Ions and Ionic Compounds

18. Each response below lists an ion by name and by chemical symbol or formula. Also each ion is classified as monatomic or polyatomic and as a cation or anion. Which response contains an **error**?
    a. phosphate / PO_4^{3-} / polyatomic / anion
    b. sulfite / SO_3^{2-} / polyatomic / anion
    c. nitrite / NO^{3-} / polyatomic / anion
    d. iron(II) / Fe^{2+} / monatomic / cation
    e. bromide / Br^- / monatomic / anion

ANS: C
OBJ: Know the names, chemical formulae, and charges of monatomic ions and common polyatomic ions.
TOP: Ions and Ionic Compounds

19. What is the formula for ammonium fluoride?
    a. AlF
    b. Al_2F_3
    c. NH_3F
    d. NH_4F_2
    e. NH_4F

    ANS: E
    OBJ: Translate the name of an ionic compound into a chemical formula.
    TOP: Names and Formulas of Some Ionic Compounds

20. What is the formula for manganese(III) oxide?
    a. MgO
    b. MnO
    c. MnO_4
    d. Mg_2O_3
    e. Mn_2O_3

    ANS: E
    OBJ: Translate the name of an ionic compound into a chemical formula.
    TOP: Names and Formulas of Some Ionic Compounds

21. What is the formula for aluminum oxide?
    a. Al_2O_3
    b. Ag_2O_3
    c. AlO_3
    d. AlO
    e. AlO_2

    ANS: A
    OBJ: Translate the name of an ionic compound into a chemical formula.
    TOP: Names and Formulas of Some Ionic Compounds

22. What is the name of $Fe(OH)_3$?
    a. iron hydroxide
    b. iron trihydroxide
    c. iron (III) hydroxide
    d. iron (II) hydroxide
    e. none of these

    ANS: C
    OBJ: Translate the name of an ionic compound into a chemical formula.
    TOP: Names and Formulas of Some Ionic Compounds

23. What is the formula for copper(II) sulfate?
    a. $CuSO_4$
    b. Cu_2SO_3
    c. $CuSO_2$
    d. Cu_2SO_4
    e. $Cu(SO_4)_2$

ANS: A
OBJ: Translate the name of an ionic compound into a chemical formula.
TOP: Names and Formulas of Some Ionic Compounds

24. Choose the name / formula pair that does not correctly match.
    a. aluminum phosphate / $AlPO_4$
    b. calcium acetate / $CaCH_3COO$
    c. ammonium sulfide / $(NH_4)_2S$
    d. magnesium hydroxide / $Mg(OH)_2$
    e. zinc carbonate / $ZnCO_3$

    ANS: B
    OBJ: Translate the chemical formula of an ionic compound into a name. | Translate the name of an ionic compound into a chemical formula.
    TOP: Names and Formulas of Some Ionic Compounds

25. From the following ionic compounds, choose the name / formula pair that is not correctly matched.
    a. sodium sulfide / Na_2S
    b. ammonium nitrate / NH_4NO_3
    c. zinc hydroxide / $Zn(OH)_2$
    d. sodium sulfate / Na_2SO_3
    e. calcium oxide / CaO

    ANS: D
    OBJ: Translate the chemical formula of an ionic compound into a name. | Translate the name of an ionic compound into a chemical formula.
    TOP: Names and Formulas of Some Ionic Compounds

26. From the following compounds choose the name / formula pair that is incorrectly matched.
    a. sodium sulfite / Na_2SO_3
    b. ammonium fluoride / NH_4F
    c. copper(II) carbonate / $CuCO_3$
    d. ferric chloride / $FeCl_3$
    e. cuprous sulfide / Co_2S

    ANS: E
    OBJ: Translate the chemical formula of an ionic compound into a name. | Translate the name of an ionic compound into a chemical formula.
    TOP: Names and Formulas of Some Ionic Compounds

27. Which element has a mass that is 7.30 times that of carbon-12?
    a. Mg
    b. Sr
    c. Ca
    d. Br
    e. Rb

    ANS: B
    OBJ: Apply the modern definition of relative atomic mass.
    TOP: Atomic Weights

28. Which element has a mass approximately 4 times that of an H atom?
    a. Be
    b. He
    c. Li
    d. Ti
    e. K

    ANS: B
    OBJ: Apply the concept of relative atomic mass.
    TOP: Atomic Weights

29. The molecular formula for a compound is CX_4. If 2.819 g of this compound contains 0.102 g of carbon, what is the atomic weight of X?
    a. 320
    b. 160
    c. 35.5
    d. 79.9
    e. 39.9

    ANS: D
    DIF: Harder Question
    OBJ: Calculate the atomic weight of an unknown element based on the chemical formula and mass of each component in a sample.
    TOP: Atomic Weights

30. How many atoms of hydrogen are in 1.00 mole of water?
    a. 6.02×10^{23}
    b. 1.20×10^{24}
    c. 1.81×10^{24}
    d. 2.41×10^{24}
    e. 3.01×10^{23}

    ANS: B
    OBJ: Translate the name of a binary molecule into a chemical formula. | Use Avogadro's number and the molecular formula to convert moles of a substance to number of atoms.
    TOP: The Mole

31. Calculate the number of moles of oxygen atoms in 35.2 grams of oxygen.
    a. 2.20 moles
    b. 4.42 moles
    c. 0.54 moles
    d. 2.57 moles
    e. 1.13 moles

    ANS: A
    OBJ: Translate the name of a diatomic element into a chemical formula. | Use the formula weight or molecular weight of a substance to convert grams of a substance to moles.
    TOP: The Mole

32. How many grams are contained in 0.644 mol oxygen?
    a. 10.3 g
    b. 20.6 g
    c. 0.0201 g
    d. 0.0403 g
    e. 0.644 g

ANS: B
OBJ: Translate the name of a diatomic element into a chemical formula. | Use the formula weight or molecular weight of a substance to convert moles of a substance to grams.
TOP: The Mole

33. Calculate the mass of one bromine atom.
    a. 2.654×10^{-22} g
    b. 6.022×10^{23} g
    c. 1.661×10^{-24} g
    d. 4.812×10^{25} g
    e. 1.327×10^{-22} g

    ANS: E
    OBJ: Use Avogadro's number and atomic weight to convert the number of atoms to grams.
    TOP: The Mole

34. Determine the number of sulfur atoms in 27.1 g of molecular sulfur (S_8).
    a. 0.845
    b. 5.27×10^{23}
    c. 5.09×10^{23}
    d. 2.07×10^{23}
    e. 0.106

    ANS: C
    OBJ: Determine the molecular weight of a substance using atomic weights and the chemical formula. | Use Avogadro's number, molecular formula, and molecular weight to convert grams to number of atoms.
    TOP: The Mole

35. Calculate the formula weight of $NaHSO_4$.
    a. 193 amu
    b. 104 amu
    c. 120 amu
    d. 215 amu
    e. 185 amu

    ANS: C
    OBJ: Determine the formula weight of a substance using atomic weights and the chemical formula.
    TOP: Formula Weights, Molecular Weights, and Moles

36. Determine the formula weight of $Ca_3(PO_4)_2$.
    a. 230 amu
    b. 279 amu
    c. 215 amu
    d. 310 amu
    e. 135 amu

    ANS: D
    OBJ: Determine the formula weight of a substance using atomic weights and the chemical formula.
    TOP: Formula Weights, Molecular Weights, and Moles

37. What is the mass of 2.2×10^9 CO_2 molecules?
    a. 9.7×10^{10} g
    b. 1.0×10^{-12} g
    c. 1.2×10^{6} g
    d. 4.4×10^{-14} g
    e. 1.6×10^{-13} g

    ANS: E
    OBJ: Determine the molecular weight of a substance using atomic weights and the chemical formula. | Use Avogadro's number and molecular weight to convert molecules to grams.
    TOP: Formula Weights, Molecular Weights, and Moles

38. What is the mass of 0.432 moles of $C_8H_9O_4$?
    a. 86.9 g
    b. 391 g
    c. 169 g
    d. 113.8 g
    e. 73.0 g

    ANS: E
    OBJ: Determine the molecular weight of a substance using atomic weights and the chemical formula. | Use the formula weight or molecular weight of a substance to convert moles to grams.
    TOP: Formula Weights, Molecular Weights, and Moles

39. How many grams of $CaCl_2$ equal 4.26 moles of $CaCl_2$?
    a. 26.1 g
    b. 170 g
    c. 302 g
    d. 473 g
    e. 322 g

    ANS: D
    OBJ: Determine the formula weight of a substance using atomic weights and the chemical formula. | Use the formula weight or molecular weight of a substance to convert moles to grams.
    TOP: Formula Weights, Molecular Weights, and Moles

40. How many moles of $POCl_3$ are there in 10.0 grams of $POCl_3$?
    a. 6.51×10^{-2} mol
    b. 3.68×10^{-1} mol
    c. 4.09×10^{-2} mol
    d. 1.21×10^{-1} mol
    e. 1.17×10^{-3} mol

    ANS: A
    OBJ: Determine the molecular weight of a substance using atomic weights and the chemical formula. | Use the formula weight or molecular weight of a substance to convert grams to moles.
    TOP: Formula Weights, Molecular Weights, and Moles

41. How many moles of CCl_4 are present in 118. g of carbon tetrachloride?
    a. 0.839
    b. 1.19
    c. 0.538
    d. 1.30
    e. 0.767

ANS: E
OBJ: Determine the molecular weight of a substance using atomic weights and the chemical formula. | Use the formula weight or molecular weight of a substance to convert grams to moles.
TOP: Formula Weights, Molecular Weights, and Moles

42. How many molecules are contained in 5.00 grams of NH_3?
    a. 5.42×10^{22}
    b. 3.00×10^{24}
    c. 3.40×10^{22}
    d. 1.77×10^{23}
    e. 9.45×10^{22}

    ANS: D
    OBJ: Determine the molecular weight of a substance using atomic weights and the chemical formula. | Use Avogadro's number and molecular weight or formula weight to convert grams to molecules.
    TOP: Formula Weights, Molecular Weights, and Moles

43. A 12.0-gram sample of $Cr_2(SO_4)_3$ contains how many sulfur atoms?
    a. 1.84×10^{22}
    b. 1.53×10^{21}
    c. 4.82×10^{21}
    d. 6.67×10^{22}
    e. 5.52×10^{22}

    ANS: E
    OBJ: Determine the formula weight of a substance using atomic weights and the chemical formula. | Use Avogadro's number, molecular formula, and formula weight to convert grams to atoms.
    TOP: Formula Weights, Molecular Weights, and Moles

44. How many atoms of carbon are present in 34.5 g of caffeine, $C_8H_{10}N_4O_2$?
    a. 8.57×10^{23}
    b. 2.68×10^{25}
    c. 1.08×10^{24}
    d. 2.09×10^{23}
    e. 4.83×10^{23}

    ANS: A
    OBJ: Determine the molecular weight of a substance using atomic weights and the chemical formula. | Use Avogadro's number, molecular formula, and molecular weight to convert grams to atoms.
    TOP: Formula Weights, Molecular Weights, and Moles

45. What is the mass in grams of 5.00×10^{12} water molecules?
    a. 1.50×10^{-10} g
    b. 1.67×10^{35} g
    c. 2.17×10^{12} g
    d. 6.69×10^{9} g
    e. 4.61×10^{-13} g

    ANS: A
    OBJ: Translate the name of a binary molecule into a formula. | Determine the molecular weight of a substance using atomic weights and the chemical formula. | Use Avogadro's number and molecular weight to convert molecules to grams.
    TOP: Formula Weights, Molecular Weights, and Moles

46. Which of the following is **not** a correct description of 16.0 grams of methane, CH_4?
    a. It is one mole of methane.
    b. It is the amount of methane that contains 12.0 g of carbon.
    c. It is $16.0 \times 6.02 \times 10^{23}$ molecules of methane.
    d. It is the amount of methane that contains 4.0 grams of hydrogen.
    e. It is the amount of methane that contains $4 \times 6.02 \times 10^{23}$ hydrogen atoms.

    ANS: C
    OBJ: Determine the molecular weight of a substance using atomic weights and the chemical formula.| Convert grams of a substance to moles, grams of a component, molecules, or atoms.
    TOP: Formula Weights, Molecular Weights, and Moles

47. A sample of ethane, C_2H_6, contains a total of $16N$ atoms, where $N = 6.02 \times 10^{23}$. How much C_2H_6 is in the sample?
    a. 2.0 g
    b. 30 g
    c. 60 g
    d. 16 mol
    e. 4 mol

    ANS: C DIF: Harder Question
    OBJ: Determine the molecular weight of a substance using atomic weights and the formula of the substance.| Use Avogadro's number, molecular formula, and molecular weight to convert total atoms in a sample to grams or moles.
    TOP: Formula Weights, Molecular Weights, and Moles

48. Suppose you have a 100-gram sample of each of the following compounds. Which sample contains the smallest number of moles of compound?
    a. NH_3
    b. $MgCl_2$
    c. H_3PO_4
    d. $CrCl_3$
    e. NaCl

    ANS: D
    OBJ: Understand and apply the relationship between mass, molar mass, and moles of a sample.
    TOP: Formula Weights, Molecular Weights, and Moles

49. A mole of a compound composed of nitrogen and oxygen (N_xO_y) has a molecular weight of 92.0 g/mol. What is its formula?
    a. NO
    b. N_2O_4
    c. NO_3
    d. N_2O
    e. NO_2

    ANS: B
    OBJ: Translate molecular weight into a molecular formula.
    TOP: Formula Weights, Molecular Weights, and Moles

50. What is the percent by mass of sulfur in $Al_2(SO_4)_3$?
    a. 9.38%
    b. 18.8%
    c. 24.6%
    d. 28.1%
    e. 35.4%

    ANS: D
    OBJ: Calculate percent mass of a component given the chemical formula of the substance.
    TOP: Percent Composition and Formulas of Compounds

51. Calculate the percent by mass of nitrogen in ammonium carbonate, NH_4NO_3.
    a. 17.5%
    b. 27.8%
    c. 29.2%
    d. 35.0%
    e. 2.86%

    ANS: D
    OBJ: Calculate percent mass of a component given the chemical formula of the substance.
    TOP: Percent Composition and Formulas of Compounds

52. Calculate the percent composition of K_2CO_3.
    a. % K = 58.2% % C = 17.9% % O = 23.9%
    b. % K = 28.2% % C = 8.8% % O = 35.9%
    c. % K = 56.6% % C = 8.7% % O = 34.7%
    d. % K = 39.4% % C = 12.0% % O = 48.4%
    e. % K = 35.1% % C = 21.6% % O = 43.2%

    ANS: C
    OBJ: Calculate percent mass of a component given the chemical formula of the substance.
    TOP: Percent Composition and Formulas of Compounds

53. What is the percentage of carbon in potassium hydrogen phthalate, $KC_6H_4(COO)(COOH)$?
    a. 35.2%
    b. 58.2%
    c. 47.1%
    d. 70.6%
    e. 19.2%

    ANS: C
    OBJ: Calculate percent mass of a component given the chemical formula of the substance.
    TOP: Percent Composition and Formulas of Compounds

54. Analysis of a sample of a covalent compound showed that it contained 14.4% hydrogen and 85.6% carbon by mass. What is the empirical formula for this compound?
    a. CH
    b. CH_2
    c. CH_3
    d. C_2H_4
    e. C_2H_5

    ANS: B
    OBJ: Convert percent mass to the simplest formula (empirical formula).
    TOP: Derivation of Formulas from Elemental Composition

55. What is the empirical formula for a compound containing 68.3% lead, 10.6% sulfur and the remainder oxygen?
    a. $PbSO_2$
    b. $PbSO_3$
    c. PbS_2O_3
    d. $PbSO_4$
    e. Pb_2SO_4

    ANS: D
    OBJ: Calculate the percent mass of a third component from the data provided. | Convert percent mass to the simplest formula (empirical formula).
    TOP: Derivation of Formulas from Elemental Composition

56. A compound contains sulfur, oxygen, and chlorine. Analysis shows that it contains by mass 26.95% sulfur and 59.61% chlorine. What is the simplest formula for this compound?
    a. SOCl
    b. $SOCl_2$
    c. SO_2Cl_2
    d. SO_2Cl
    e. S_2OCl_2

    ANS: B
    OBJ: Calculate the percent mass of a third component from the data provided. | Convert percent mass to the simplest formula (empirical formula).
    TOP: Derivation of Formulas from Elemental Composition

57. A compound contains carbon, oxygen, and hydrogen. Analysis of a sample showed that it contained by mass 68.9% carbon and 4.92% hydrogen. What is the simplest formula for this compound?
    a. $C_6H_6O_2$
    b. $C_7H_6O_2$
    c. $C_8H_6O_2$
    d. $C_6H_4O_3$
    e. C_7H_8O

    ANS: B
    OBJ: Calculate the percent mass of a third component from the data provided. | Convert percent mass to the simplest formula (empirical formula).
    TOP: Derivation of Formulas from Elemental Composition

58. A sample of a compound containing nitrogen, hydrogen, and oxygen is found to contain 22.2% nitrogen and 1.59% hydrogen. What is the simplest formula for this compound?
    a. HNO
    b. $H_2N_2O_3$
    c. H_2NO_3
    d. HNO_2
    e. HNO_3

    ANS: E
    OBJ: Calculate the percent mass of a third component from the data provided. | Convert percent mass to the simplest formula (empirical formula).
    TOP: Derivation of Formulas from Elemental Composition

59. A 4.628-g sample of an oxide of iron was found to contain 3.348 g of iron and 1.280 g of oxygen. What is simplest formula for this compound?
    a. FeO
    b. Fe_2O_3
    c. Fe_3O_4
    d. FeO_2
    e. Fe_3O_2

    ANS: C
    OBJ: Derive percent mass from experimental data. | Convert percent mass to the simplest formula (empirical formula).
    TOP: Derivation of Formulas from Elemental Composition

60. A 2.086-g sample of a compound contains 0.884 g of cobalt, 0.482 g of sulfur, and 0.720 g of oxygen. What is its simplest formula?
    a. $CoSO_3$
    b. $CoSO_4$
    c. $Co(SO_3)_2$
    d. $Co(SO_4)_2$
    e. $Co_3(SO_4)_4$

    ANS: A
    OBJ: Derive percent mass from experimental data. | Convert percent mass to the simplest formula (empirical formula).
    TOP: Derivation of Formulas from Elemental Composition

61. What is the simplest formula for Chalcocite if a sample of this ore contains 8.274 g copper and 2.088 g sulfur?
    a. CuS_3
    b. CuS
    c. CuS_2
    d. Cu_2S_3
    e. Cu_2S

    ANS: E
    OBJ: Derive percent mass from experimental data. | Convert percent mass to the simplest formula (empirical formula).
    TOP: Derivation of Formulas from Elemental Composition

62. Determine the simplest formula for a hydrocarbon if the complete combustion of a sample produces 5.28 g of CO_2 and 1.62 g of H_2O.
    a. C_2H_3
    b. CH_2
    c. CH_3
    d. CH
    e. C_2H_5

    ANS: A
    OBJ: Understand the term hydrocarbon.| Derive percent mass from experimental data. | Convert percent mass to the simplest formula (empirical formula).
    TOP: Derivation of Formulas from Elemental Composition

63. Determine the simplest formula for a hydrocarbon if the complete combustion of a sample produces 3.96 g of CO_2 and 2.16 g of H_2O.
    a. C_2H_3
    b. C_3H_8
    c. CH_3
    d. CH
    e. C_2H_5

    ANS: B
    OBJ: Understand the term hydrocarbon.| Derive percent mass from experimental data. | Convert percent mass to the simplest formula (empirical formula).
    TOP: Derivation of Formulas from Elemental Composition

64. A compound is known to contain only carbon, hydrogen, and oxygen. If the complete combustion of a 0.150-g sample of this compound produces 0.225 g of CO_2 and 0.0614 g of H_2O, what is the empirical formula of this compound?
    a. C_3H_4
    b. CH_4O
    c. C_3HO_3
    d. $C_3H_4O_3$
    e. $C_5H_7O_5$

    ANS: D
    OBJ: Calculate the mass of oxygen in the sample from the data provided. | Derive percent mass from experimental data. | Convert percent mass to the simplest formula (empirical formula).
    TOP: Derivation of Formulas from Elemental Composition

65. Glucose has a molecular weight of 180.2 g and an empirical formula CH_2O. What is its molecular formula?
    a. $C_8H_4O_5$
    b. $C_6H_{12}O_6$
    c. $C_{12}H_{22}O_{11}$
    d. $C_{10}H_{12}O_3$
    e. CH_2O

    ANS: B
    OBJ: Determine the molecular formula from the molecular weight and simplest formula (empirical formula).
    TOP: Determination of Molecular Formulas

66. A compound contains, by mass, 87.5% nitrogen and 12.5% hydrogen. Its molecular weight is found to be 32 g/mol. What is its molecular formula?
    a. N_2H_6
    b. N_2H_4
    c. N_2H_5
    d. NH_3
    e. NH_2

    ANS: B
    OBJ: Convert percent mass to the simplest formula (empirical formula). | Determine the molecular formula from the molecular weight and simplest formula (empirical formula).
    TOP: Determination of Molecular Formulas

67. A compound contains only carbon, hydrogen, and oxygen. Analysis of a sample showed that it contained 54.53% C and 9.15% H. Its molecular weight was determined to be approximately 88 g/mol. What is its molecular formula?
    a. C_2H_4O
    b. C_4H_8O
    c. C_4H_8
    d. $C_4H_8O_2$
    e. $C_4H_{12}O_2$

    ANS: D
    OBJ: Calculate the percent mass of a third component from the data provided. | Convert percent mass to the simplest formula (empirical formula). | Determine the molecular formula from the molecular weight and simplest formula (empirical formula).
    TOP: Determination of Molecular Formulas

68. Butyric acid, found in rancid butter, has a molar mass of 88 g/mol. If butyric acid is 54.5% C, 9.09% H and 36.4% O, what is the molecular formula?
    a. $C_4H_8O_2$
    b. $C_8H_{12}O_4$
    c. C_2H_4O
    d. $C_{12}H_6O$
    e. CHO_2

    ANS: A
    OBJ: Convert percent mass to the simplest formula (empirical formula). | Determine the molecular formula from the molecular weight and simplest formula (empirical formula).
    TOP: Determination of Molecular Formulas

69. A compound contains, by mass, 26.7% carbon, 71.1% oxygen and the remainder hydrogen. A 0.23 mole sample of this compound weighs 20.7 g. What is the molecular formula of this compound?
    a. $C_3H_6O_2$
    b. $C_2H_2O_4$
    c. C_2H_4O
    d. CHO_2
    e. C_3OH

    ANS: B
    OBJ: Calculate the percent mass of a third component from the data provided. | Convert percent mass to the simplest formula (empirical formula).| Calculate the molecular weight of the compound from mass and moles. | Determine the molecular formula from the molecular weight and simplest formula (empirical formula).
    TOP: Determination of Molecular Formulas

70. What is the maximum amount of carbon dioxide that can be produced by the combustion of 0.450g of C_2H_5OH?
    a. 0.861g
    b. 0.430g
    c. 1.62g
    d. 44.0g
    e. cannot be determined

ANS: A
OBJ: Translate the name of a binary molecule into a formula. | Determine the molecular weight of a substance using atomic weights and the formula of the substance.| Using molecular weights and molecular formulas, convert grams of organic compound to grams of carbon dioxide
TOP: Determination of Molecular Formulas

71. Which of the following sets illustrates the Law of Multiple Proportions?
    a. Li_2O, Na_2O, K_2O
    b. KCl, $CaCl_2$, $ScCl_3$
    c. $^{1}_{1}H$, $^{2}_{1}H$, $^{3}_{1}H$
    d. O, O_2, O_3
    e. BrF, BrF_3, BrF_5

    ANS: E
    OBJ: Identify an example of the Law of Multiple Proportions.
    TOP: Determination of Molecular Formulas

72. What is the ratio of the masses of oxygen that combine with 1.00 gram of lead in the compounds PbO, PbO_2, and Pb_2O_3?
    a. 1:2:2
    b. 1:2:1
    c. 2:4:4
    d. 6:12:8
    e. 2:4:3

    ANS: E DIF: Harder Question
    OBJ: Apply the Law of Multiple Proportions.
    TOP: Determination of Molecular Formulas

73. What mass of iron is contained in 86.6 grams of chalcopyrite, $CuFeS_2$?
    a. 26.3 g
    b. 30.4 g
    c. 55.8 g
    d. 28.5 g
    e. 11.8 g

    ANS: A
    OBJ: Determine the mass of a component in a sample from the sample mass and chemical formula.
    TOP: Some Other Interpretations of Chemical Formulas

74. What mass of tungsten is present in 10.0 lbs of wolframite, $FeWO_4$?
    a. 2.21 kg
    b. 2.75 kg
    c. 5.06 lb
    d. 0.716 kg
    e. 5.85 lb

    ANS: B
    OBJ: Convert pounds to grams. | Determine the mass of a component in a sample from the sample mass and chemical formula.
    TOP: Some Other Interpretations of Chemical Formulas

75. What mass of cerussite, $PbCO_3$, would contain 25.0 grams of lead?
    a. 19.4 g
    b. 32.2 g
    c. 29.3 g
    d. 25.4 g
    e. 36.9 g

    ANS: B
    OBJ: Determine the mass of a compound from the chemical formula and the mass of a component.
    TOP: Some Other Interpretations of Chemical Formulas

76. What mass of hematite, Fe_2O_3, would contain 24.0 kg of iron?
    a. 34.3 kg
    b. 68.3 kg
    c. 44.7 kg
    d. 30.5 kg
    e. 41.4 kg

    ANS: A
    OBJ: Convert between grams and kilograms. | Determine the mass of a compound from the chemical formula and the mass of a component.
    TOP: Some Other Interpretations of Chemical Formulas

77. What mass of fluoristan, SnF_2, would contain the same mass of tin as 306 grams of cassiterite, SnO_2?
    a. 295 g
    b. 318 g
    c. 278 g
    d. 367 g
    e. 335 g

    ANS: B DIF: Harder Question
    OBJ: Determine the mass of a component in a sample from the sample mass and chemical formula. | Determine the mass of a compound from the chemical formula and the mass of a component.
    TOP: Some Other Interpretations of Chemical Formulas

78. What mass of $FeCl_3$ would contain the same **total** number of ions as 16.8 g of $Al_2(SO_4)_3$?
    a. 7.96 g
    b. 9.95 g
    c. 10.8 g
    d. 13.3 g
    e. 8.01 g

    ANS: B
    DIF: Harder Question
    OBJ: Recognize the ions in an ionic chemical formula. | Determine the total number of ions in a sample from the mass and chemical formula. | Determine the mass of a sample from the total ions and chemical formula.
    TOP: Some Other Interpretations of Chemical Formulas

79. Heating $MgSO_4 \bullet 7H_2O$ at 150°C produces $MgSO_4 \bullet xH_2O$. If heating 24.4 g of pure $MgSO_4 \bullet 7H_2O$ at 150°C were to give 13.7 g of pure $MgSO_4 \bullet xH_2O$, calculate the value for x.
    a. 5
    b. 4
    c. 3
    d. 2
    e. 1

    ANS: E
    DIF: Harder Question
    OBJ: Determine the simplest formula of the partially (de)hydrated product from the experimental data.
    TOP: Some Other Interpretations of Chemical Formulas

80. An ore of lead is 45.0% pure lead sulfide, PbS, and 55.0% impurities in which no other lead compounds are present. What mass of lead is contained in 150.0 grams of this ore?
    a. 71.4 g
    b. 67.5 g
    c. 58.5 g
    d. 9.05 g
    e. 18.0 g

    ANS: C
    OBJ: Determine the mass of a component in a sample from the sample mass, chemical formula, and percent composition.
    TOP: Purity of Samples

81. A chemical bottle containing $BaSO_4$ is 98.7% pure. What mass of Ba is present in 162 g of this chemical?
    a. 47.1 g
    b. 96.6 g
    c. 94.1 g
    d. 98.7 g
    e. 95.3 g

    ANS: C
    OBJ: Determine the mass of a component in a sample from the sample mass, chemical formula, and percent composition.
    TOP: Purity of Samples

82. What mass of calcium metal could be obtained from one kg of limestone that is 50.0% pure $CaCO_3$? (No other calcium-containing compounds are present.)
    a. 0.05 kg
    b. 0.2 kg
    c. 0.4 kg
    d. 0.5 kg
    e. 0.1 kg

    ANS: B
    OBJ: Determine the mass of a component in a sample from the sample mass, chemical formula, and percent composition.
    TOP: Purity of Samples

83. A dolomite ore contains 40.0% pure $MgCO_3 \bullet CaCO_3$. No other compounds of magnesium or calcium are present in the ore. What mass of magnesium and what mass of calcium are contained in 100.0 grams of this ore?
    a. 18.3 g Mg / 21.7 g Ca
    b. 7.91 g Mg / 13.0 g Ca
    c. 8.70 g Mg / 31.3 g Ca
    d. 5.27 g Mg / 8.69 g Ca
    e. 34.5 g Mg / 5.30 g Ca

    ANS: D
    OBJ: Determine the mass of a component in a sample from the sample mass, chemical formula, and percent composition.
    TOP: Purity of Samples

84. A sample of lead ore has a density of 8.80 g/mL. It is composed of two lead compounds: lead oxide, PbO (density 9.10 g/mL) and lead selenide, PbSe (density 8.10 g/mL). What percent of the ore is lead oxide?
    a. 96.7 %
    b. 89.0 %
    c. 70.0 %
    d. 92.0 %
    e. 86.3 %

    ANS: C
    DIF: Harder Question
    OBJ: Determine percent composition from the density of each component and the density of the sample.
    TOP: Purity of Samples

85. A 1.4-g sample of washing soda, $Na_2CO_3 \bullet 10H_2O$, has 2.9×10^{21} carbon atoms. How many oxygen atoms are present in 1.4 g of washing soda?
    a. 2.9×10^{22}
    b. 2.9×10^{21}
    c. 4.1×10^{21}
    d. 3.8×10^{22}
    e. 8.8×10^{21}

    ANS: D
    DIF: easy
    OBJ: Convert between number of atoms given the formula.
    TOP: Formula Weights, Molecular Weights, and Moles

86. Manganese(III) monohydrogen phosphate is an ionic compound formed from Mn^{3+} and HPO_4^{2-}. What is the correct way to represent the formula?

    a. $MnHPO_4^+$
    b. $Mn(HPO_4)_2^-$
    c. $Mn^{3+}HPO_4^{2-}$
    d. $Mn_2(HPO_4)_3$
    e. $Mn_6(HPO_4)_9$

ANS: D
DIF: easy
OBJ: Write an ionic formula, given the name of the compound.
TOP: Names and Formulas of Some Ionic Compounds

87. How many oxygen atoms are there in a formula unit of $UO_2(C_2H_3O_2)_2 \cdot NH_4C_2H_3O_2 \cdot 5H_2O$?
a. 4
b. 13
c. 23
d. 9
e. 11

ANS: B
DIF: easy
OBJ: Determine the number of oxygen atoms in a formula unit.
TOP: Chemical Formulas

88. The correct name for Fe^{2+} is

a. monoiron ion.
b. iron(II) ion.
c. iron ion.
d. iron(I) ion.
e. iron.

ANS: B
DIF: easy
OBJ: Name the monatomic ions.
TOP: Ions and Ionic Compounds

89. The formula of magnesium sulfide is
a. MgS.
b. $MgSO_2$.
c. $MgSO_4$.
d. $MgSO_3$.
e. $Mg(SO_4)_2$.

ANS: A
DIF: easy
OBJ: Write the formula of an ionic compound given its name.
TOP: Names and Formulas of Some Ionic Compounds

90. What is the subscript of potassium in the formula for potassium sulfate?
a. 2
b. 5
c. 3
d. 4
e. 1

ANS: A
DIF: easy
OBJ: Write the formula of an ionic compound given its name.
TOP: Names and Formulas of Some Ionic Compounds

91. The fully hydrated form of sodium sulfate is the decahydrate, $Na_2SO_4 \cdot 10H_2O$. When heated the hydrated salt loses water. How many water molecules are found per formula unit in a partially dehydrated sample of sodium sulfate with a formula mass of 214.1 amu (i.e. find n for $Na_2SO_4 \cdot nH_2O$)?

a. 4 waters.
b. 9 waters.
c. 1 waters.
d. 6 waters.
e. 5 waters.

ANS: A
DIF: moderate
OBJ: Calculate the moles of water per formula unit from dehydration data.
TOP: Some Other Interpretations of Chemical Formulas

92. What is the molecular mass of cyclooctane, C_8H_{16}?
a. 13.02 amu
b. 1553.53 amu
c. 97.10 amu
d. 112.21 amu
e. 28.14 amu

ANS: D
DIF: easy
OBJ: Calculate the formula mass given the formula.
TOP: Formula Weights, Molecular Weights, and Moles

93. A 1.488 g sample of an element contains 8.708×10^{21} atoms. What is the element symbol?

a. Rh
b. Sn
c. Cd
d. Ag
e. Te

ANS: A
DIF: moderate
OBJ: Convert a mass and number of atoms to a formula weight.
TOP: Formula Weights, Molecular Weights, and Moles

94. What is the empirical formula of an oxide of nitrogen that contains 36.84 % nitrogen by mass?
a. NO
b. N_2O_5
c. NO_2
d. N_2O
e. N_2O_3

ANS: E
DIF: moderate
OBJ: Determine the empirical formula from the percentage composition.
TOP: Percent Composition and Formulas of Compounds

95. Which of the following samples contains the greatest number of atoms?
a. 7.25g Li b. 73.21g Zn c. 90.00g Br d. 140.87g Sb e. 152.11g Cs

ANS: D
OBJ: Identify the sample with the greatest number of atoms.
TOP: Formula Weights, Molecular Weights, and Moles

96. How many atoms of chlorine are present in 2.42 grams of boron trichloride, BCl_3?
a. 1.24×10^{22} atoms
b. 3.73×10^{22} atoms
c. 4.15×10^{21} atoms
d. 5.69×10^{25} atoms
e. 5.14×10^{26} atoms

ANS: B
OBJ: Determine the number of atoms of one atom type in a compound.
TOP: Formula Weights, Molecular Weights, and Moles

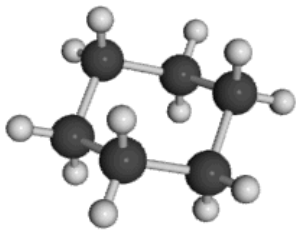
97. How many moles of calcium are there in a sample of calcium that contains 1.48×10^{24} atoms?
a. 0.407 mol b. 2.46 mol c. 3.57 mol d. 16.3 mol e. 98.5 mol

ANS: B
OBJ: Determine the number of moles given number of atoms.
TOP: Formula Weights, Molecular Weights, and Moles

98. How many ammonia (NH_3) molecules are there in a 115 g sample of ammonia?
a. 3.07×10^{20}
b. 5.24×10^{21}
c. 1.91×10^{22}
d. 4.06×10^{24}
e. 1.18×10^{27}

ANS: D
OBJ: Determine the number of molecules in a sample.
TOP: Formula Weights, Molecular Weights, and Moles

99. What are the empirical and molecular formulas for the following compound?



(C = dark atoms, H = light atoms)
a. C_6H_6 (molecular) CH (empirical)
b. C_6H_{12} (molecular) CH_2 (empirical)
c. CH (molecular) C_6H_6 (empirical)
d. CH_2 (molecular) C_6H_{12} (empirical)

ANS: B
OBJ: Determine the empirical and molecular formula given the ball and stick model.
TOP: Chemical Formulas

100. When the element magnesium reacts, it forms the ion:
a. Mg^{2+}
b. Mg^{+}
c. Mn^{2+}
d. Mn^{+}
e. Cannot tell – it has a variable charge

ANS: A
OBJ: Determine the charge of a group 2A metal in its compounds.
TOP: Names and Formulas of Some Ionic Compounds

101. What is the correct systematic name for Na_2SO_3?
a. Sodium sulfate
b. Sodium sulfite
c. Sodium(III) sulfate
d. Disodium trisulfide
e. Disodium monosulfate

ANS: B
OBJ: Name the ionic compound of a polyatomic ion.
TOP: Names and Formulas of Some Ionic Compounds

102. What is the formula for the compound which forms between the ammonium ion and bromide ion?
a. NH_3Br
b. NH_4Br
c. NH_3Br_2
d. NH_4Br_2
e. $(NH_4)_2Br$

ANS: B
OBJ: Name the ionic compound of a polyatomic ion.
TOP: Names and Formulas of Some Ionic Compounds

103. Which of the following pairs is ***incorrect***?
a. $CaCl_2$, calcium chloride
b. $Fe(OH)_3$, iron(III) hydroxide
c. $KMnO_4$, potassium permanganate
d. $LiCr_2O_7$, lithium dichromate
e. CCl_4, carbon tetrachloride

ANS: D
OBJ: Identify the incorrect ionic compound formula and name.
TOP: Names and Formulas of Some Ionic Compounds

104. What is the chemical formula for nitric acid?
a. HNO_2 b. HNO_3 c. HNO_4 d. H_2NO_3 e. H_2NO_2

ANS: B
OBJ: Identify the formula given the acid name.
TOP: Names and Formulas of Some Molecular Compounds

CONCEPTUAL

1. Discuss the accuracy of this statement: All matter in the universe in made of only three particles.

   OBJ: Define matter.
   TOP: Structure of the Atom

2. Why isn't it correct to refer to a molecule of aluminum chloride?

   OBJ: Distinguish between properties that define a substance as ionic or molecular.
   TOP: Chemical Formulas | Ions and Ionic Compounds

3. Would atomic weights of elements be different if another standard was chosen to represent the atomic mass unit (amu)? Would their relative masses change?

   OBJ: Define atomic mass unit.| Define relative atomic mass.| Discuss the effect using a standard other than C-12 to define atomic mass units.

4. Explain how it is possible for many different compounds to have the same empirical formula.

   OBJ: Compare and contrast the terms simplest formula (empirical formula) and molecular formula.
   TOP: Chemical Formulas

5. Why is the purity of a chemical listed on the label? Are there any situations where purity is not very important?

   OBJ: Discuss the importance of purity in chemistry and chemistry related applications.
   TOP: Purity of Samples

6. You are in charge of making a backup oxygen generator for the space shuttle. The chemical compounds that will decompose to give oxygen in your system are $LiClO_3$ or $KClO_3$. Which compound would you choose and why?

   OBJ: Understand and apply the relationship between mass, molar mass, and moles of a sample.| Compare the quantities of dioxygen produced from identical amounts of chlorate salts.
   TOP: Formula Weights, Molecular Weights, and Moles