Chapter 03: Stoichiometry

A periodic table will be required to answer some of these questions.

1. An atom of helium has a mass about four times greater than that of an atom of hydrogen. Which choice makes the correct comparison of the relative numbers of helium and hydrogen atoms in equal masses of the two elements?
   A) There are about four times as many helium atoms as hydrogen atoms.
   B) There are about two times as many helium atoms as hydrogen atoms.
   C) The number of helium and hydrogen atoms is the same.
   D) There are about half as many helium atoms as hydrogen atoms.
   E) There are about one-fourth as many helium atoms as hydrogen atoms.

3. An atom of bromine has a mass about four times greater than that of an atom of neon. Which choice makes the correct comparison of the relative numbers of bromine and neon atoms in 1,000 g of each element?
   A) The number of bromine and neon atoms is the same.
   B) There are one thousand times as many bromine atoms as neon atoms.
   C) There are one thousand times as many neon atoms as bromine atoms.
   D) There are four times as many neon atoms as bromine atoms.
   E) There are four times as many bromine atoms as neon atoms.

5. An average atom of uranium (U) is approximately how many times heavier than an atom of potassium?
   A) 6.1 times B) 4.8 times C) 2.4 times D) 12.5 times E) 7.7 times

7. The element oxygen consists of three naturally occuring isotopes: ^{16}O, ^{17}O, and ^{18}O. The atomic mass of oxygen is 16.0 amu. What can be implied about the relative abundances of these isotopes?
   A) More than 50% of all O atoms are ^{17}O.
   B) Almost all O atoms are ^{18}O.
   C) Almost all O atoms are ^{17}O.
   D) The isotopes all have the same abundance, i.e. 33.3%.
   E) The abundances of ^{17}O and ^{18}O are very small.

9. What is the average mass, in grams, of one atom of iron?
   A) 6.02×10^{23} g
   B) 1.66×10^{-24} g
   C) 9.28×10^{-23} g
   D) 55.85 g
   E) 55.85×10^{-23} g

11. The mass of 1.21×10^{20} atoms of sulfur is
A) 3.88×10^{21} g. B) 2.00 mg. C) 32.06 g. D) 6.44 mg. E) 2.00×10^{-4} g.

13. What is the mass of 7.80×10^{18} carbon atoms?
A) 1.30×10^{-5} g
B) 6.43×10^{3} g
C) 7.80×10^{18} g
D) 1.56×10^{-4} g
E) 12.01 g

15. One mole of iron
A) is heavier than one mole of lead (Pb).
B) is 77.0 g of iron.
C) is 26.0 g of iron.
D) weighs the same as one mole of lead.
E) None of the above.

17. One nanogram does not seem like a very large number. How many magnesium atoms are there in 1.00 ng of magnesium?
A) 4.11×10^{-11} atoms
B) 2.48×10^{13} atoms
C) 6.83×10^{-35} atoms
D) 6.02×10^{14} atoms
E) 1.46×10^{34} atoms

19. Determine the number of moles of aluminum in 96.7 g of Al.
A) 0.279 mol B) 3.58 mol C) 7.43 mol D) 4.21 mol E) 6.02×10^{23} mol

21. A gold wire has a diameter of 1.00 mm. What length of this wire contains exactly 1.00 mol of gold? (density of Au = 17.0 g/cm^3)
A) 2630 m B) 3.69 m C) 251 m D) 14.8 m E) 62.7 m

23. A copper wire has a diameter of 2.00 mm. What length of this wire contains exactly 1.00 mol of copper? (density of Cu = 8.92 g/cm^3)
A) 0.178 m B) 0.567 m C) 180 m D) 45.1 m E) 2.27 m

25. How many atoms are in 4.39 g of CO_2?
A) 1.80×10^{23} atoms
B) 6.01×10^{22} atoms
C) 1.16×10^{26} atoms
D) 6.04×10^{24} atoms
E) 1.81×10^{25} atoms

27. How many moles of CF_4 are there in 171 g of CF_4?
A) 0.51 mol B) 1.94 mol C) 4.07 mol D) 88.0 mol E) 171 mol

29. Calculate the number of moles of cesium in 50.0 g of cesium.
A) 0.376 mol B) 0.357 mol C) 2.66 mol D) 2.80 mol E) 0.0200 mol

31. Calculate the molecular mass of potassium permanganate, $KMnO_4$.
A) 52 amu B) 70 amu C) 110 amu D) 158 amu E) 176 amu

33. What is the molar mass of acetaminophen, $C_8H_9NO_2$?
A) 43 g/mol B) 76 g/mol C) 151 g/mol D) 162 g/mol E) 125 g/mol

35. What is the mass of 0.0250 mol of P_2O_5?
A) 35.5 g B) 5676 g C) 0.0250 g D) 1.51×10^{22} g E) 3.55 g

37. The molecular formula of aspirin is $C_9H_8O_4$. How many aspirin molecules are present in one 500-milligram tablet?
A) 2.77 molecules
B) 2.77×10^{-3} molecules
C) 1.67×10^{24} molecules
D) 1.67×10^{21} molecules
E) None of these is correct.

39. How many molecules are there in 8.0 g of ozone, O_3?
A) 3 molecules
B) 3.6×10^{24} molecules
C) 1.0×10^{23} molecules
D) 3.0×10^{23} molecules
E) 6.0×10^{23} molecules

41. How many sodium atoms are there in 6.0 g of Na_3N?
A) 3.6×10^{24} atoms
B) 4.6×10^{22} atoms
C) 1.3×10^{23} atoms
D) 0.217 atoms
E) 0.072 atoms

43. How many sulfur atoms are there in 21.0 g of Al_2S_3?
A) 8.42×10^{22} atoms
B) 2.53×10^{23} atoms
C) 2.14×10^{23} atoms
D) 6.02×10^{23} atoms
E) 6.30×10^{26} atoms

45. How many fluorine atoms are there in 65 g of CF_4?
A) 0.74 atoms
B) 3.0 atoms
C) 4.5×10^{23} atoms
D) 1.8×10^{24} atoms
E) 2.4×10^{23} atoms

47. How many O atoms are there in 51.4 g $CaSO_4$?
A) 4 B) 2.40×10^{24} C) 1.13 D) 9.09×10^{23} E) 2.28×10^{23}

49. How many carbon atoms are there in 10 lbs of sugar, $C_{12}H_{22}O_{11}$?
A) 9.6×10^{25} atoms
B) 8.0×10^{24} atoms
C) 159 atoms
D) 4.21 atoms
E) 342 atoms

51. How many grams of sodium are there in 10. g of sodium sulfate, Na_2SO_4?
A) 0.16 g B) 0.32 g C) 3.2 g D) 1.6 g E) 142 g

53. The mass of four moles of molecular bromine (Br_2) is
A) 80 g. B) 320 g. C) 640 g. D) 140 g. E) 24×10^{23} g.

55. What is the mass of 3.00 moles of ethanol, C_2H_6O?
A) 4.99×10^{-24} g B) 138 g C) 6.52×10^{-2} g D) 50 g E) 1.81×10^{24} g

57. What is the mass of 8.25×10^{19} UF_6 molecules?
A) 352 g B) 0.0482 g C) 1.37×10^{-4} g D) 2.90×10^{22} g E) 8.25×10^{19} g

59. The empirical formula of a compound of uranium and fluorine that is composed of 67.6% uranium and 32.4% fluorine is
A) U_2F. B) U_3F_4. C) UF_4. D) UF_6. E) UF_8.

61. A compound was discovered whose composition by mass is 85.6% C and 14.4% H. Which of the following could be the molecular formula of this compound?
A) CH_4 B) C_2H_4 C) C_3H_4 D) C_2H_6 E) C_3H_8

63. The percent composition by mass of an unknown chlorinated hydrocarbon was found to be 37.83% C, 6.35% H, and 55.83% Cl by mass. What is the empirical formula of this compound?
A) C_2H_4Cl B) C_3H_7Cl C) $C_3H_6Cl_2$ D) C_4H_9Cl E) $C_5H_{11}Cl$

65. What is the coefficient of H_2O when the following equation is properly balanced with the smallest set of whole numbers?
___ Na + ___ $H_2O \rightarrow$ ___ NaOH + ___ H_2
A) 1 B) 2 C) 3 D) 4 E) 5

67. When balanced with smallest set of whole numbers, the coefficient of O_2 in the following equation is
__ C_2H_4 + __ $O_2 \rightarrow$ __ CO_2 + __ H_2O
A) 1. B) 2. C) 3. D) 4. E) 6.

69. What is the coefficient preceding O_2 when the following combustion reaction of a fatty acid is properly balanced using the smallest set of whole numbers?
__ $C_{18}H_{36}O_2$ + __ $O_2 \rightarrow$ __ CO_2 + __ H_2O
A) 1 B) 8 C) 9 D) 26 E) 27

71. Balance the equation below using the smallest set of whole numbers. What is the coefficient of H_2O?
___ $PCl_3(l)$ + ___ $H_2O(l) \rightarrow$ ___ $H_3PO_3(aq)$ + ___ $HCl(aq)$
A) 1 B) 2 C) 3 D) 5 E) none of these

73. Balance the following equation using the smallest set of whole numbers, then add together the coefficients. Do not forget to count coefficients of one. The sum of the coefficients is
__ SF_4 + __ $H_2O \rightarrow$ __ H_2SO_3 + __ HF
A) 4. B) 6. C) 7. D) 9. E) none of these.

75. Balance the following equation using the smallest set of whole numbers, then add together the coefficients. Do not forget to count coefficients of one. The sum of the coefficients is
___ Al + ___ $H_2SO_4 \rightarrow$ ___ $Al_2(SO_4)_3$ + ___ H_2
A) 3. B) 5. C) 6. D) 9. E) 12.

77. Ammonia reacts with diatomic oxygen to form nitric oxide and water vapor:
$4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$
When 40.0 g NH_3 and 50.0 g O_2 are allowed to react, which is the limiting reagent?
A) NH_3 B) O_2 C) NO D) H_2O E) No reagent is limiting.

79. When 22.0 g NaCl and 21.0 g H_2SO_4 are mixed and react according to the equation below, which is the limiting reagent?
$2NaCl + H_2SO_4 \rightarrow Na_2SO_4 + 2HCl$
A) NaCl B) H_2SO_4 C) Na_2SO_4 D) HCl E) No reagent is limiting.

81. Chlorine gas can be made from the reaction of manganese dioxide with hydrochloric acid.
$MnO_2(s) + 4HCl(aq) \rightarrow MnCl_2(aq) + 2H_2O(l) + Cl_2(g)$
According to the above reaction, which is the limiting reagent when 28 g of MnO_2 are reacted with 42 g of HCl?
A) MnO_2 B) HCl C) $MnCl_2$ D) Cl_2 E) No reagent is limiting.

83. Hydrogen chloride gas can be prepared by the following reaction:
$2NaCl(s) + H_2SO_4(aq) \rightarrow 2HCl(g) + Na_2SO_4(s)$
How many grams of HCl can be prepared from 2.00 mol H_2SO_4 and 150 g NaCl?
A) 7.30 g B) 93.5 g C) 146 g D) 150 g E) 196 g

85. What is the theoretical yield of chromium that can be produced by the reaction of 40.0 g of Cr_2O_3 with 8.00 g of aluminum according to the chemical equation below?
$2Al + Cr_2O_3 \rightarrow Al_2O_3 + 2Cr$
A) 7.7 g B) 15.4 g C) 27.3 g D) 30.8 g E) 49.9 g

87. What is the maximum number of grams of ammonia, NH_3, that can be obtained from the reaction of 10.0 g of H_2 and 80.0 g of N_2?
$N_2 + 3H_2 \rightarrow 2NH_3$
A) 28.4 g B) 48.6 g C) 56.7 g D) 90.0 g E) 97.1 g

89. Ammonia reacts with diatomic oxygen to form nitric oxide and water vapor:
$4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$
What is the theoretical yield of water, in moles, when 40.0 g NH_3 and 50.0 g O_2 are mixed and allowed to react?
A) 1.30 mol B) 1.57 mol C) 1.87 mol D) 3.53 mol E) None of these.

91. What is the theoretical yield of vanadium, in moles, that can be produced by the reaction of 1.0 mole of V_2O_5 with 4.0 mole of calcium based on the following chemical reaction?
$V_2O_5(s) + 5Ca(l) \rightarrow 2V(l) + 5CaO(s)$
A) 1.0 mol B) 1.6 mol C) 2.0 mol D) 0.80 mol E) None of these

93. How many grams of Cr can be produced by the reaction of 44.1 g of Cr_2O_3 with 35.0 g of Al according to the following chemical reaction?
$2Al + Cr_2O_3 \rightarrow Al_2O_3 + 2Cr$
A) 7.56 g B) 30.2 g C) 67.4 g D) 104 g E) None of these.

95. A 1.375 g sample of mannitol, a sugar found in seaweed, is burned completely in oxygen to give 1.993 g of carbon dioxide and 0.9519 g of water. The empirical formula of mannitol is
A) CHO. B) CH_7O_3. C) C_3H_2O. D) $C_3H_7O_3$. E) CH_2O.

97. An oxyhydrocarbon produced in a chemical reaction was determined to have a molecular mass of 120.20 g/mol. Which of the following is a possible empirical formula for this compound?
A) CH_4O B) C_2H_6O C) C_3H_8O D) $C_3H_8O_2$ E) $C_4H_{10}O_2$

99. The first step in the Ostwald process for producing nitric acid is
$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$.
If the reaction of 150. g of ammonia with 150. g of oxygen gas yields 87. g of nitric oxide (NO), what is the percent yield of this reaction?
A) 100% B) 49% C) 77% D) 33% E) 62%

101. When octane (C_8H_{18}) is burned in a particular internal combustion engine, the yield of products (carbon dioxide and water) is 93%. What mass of carbon dioxide will be produced in this engine when 15.0 g of octane is burned with 15.0 g of oxygen gas?
A) 13. g B) 12. g C) 21. g D) 54. g E) 43. g

103. The Hall process for the production of aluminum involves the reaction of aluminum oxide with elemental carbon to give aluminum metal and carbon monoxide. If the yield of this reaction is 82% and aluminum ore is 71% by mass aluminum oxide, what mass of aluminum ore must be mined in order to produce 1.0×10^3 kg (1 metric ton) of aluminum metal by the Hall process?

A) 1.8×10^3 kg
B) 2.2×10^3 kg
C) 1.1×10^3 kg
D) 1.6×10^3 kg
E) 3.3×10^3 kg

105. Solid sodium hydrogen carbonate (also known as sodium bicarbonate) can be decomposed to form solid sodium carbonate, gaseous carbon dioxide, and water vapor. When the balanced chemical reaction for this process is written such that the coefficient of water is 1, what is the coefficient of carbon dioxide?

A) 0 B) 1 C) 2 D) ½ E) cannot be determined

107. Liquid hexane, C_6H_{14}, burns in oxygen gas to yield carbon dioxide and water. What is the minimum mass of oxygen required for the complete reaction of 10.0 mL of hexane? (density of hexane = 0.660 g/mL)

A) 3.71 g B) 2.45 g C) 23.3 g D) 46.6 g E) 35.3 g

109. Liquid heptane, C_7H_{16}, burns in oxygen gas to yield carbon dioxide and water. What mass of water is produced when 15.0 mL of heptane burns completely? (density of heptane = 0.6838 g/mL)

A) 14.8 g B) 2.70 g C) 31.6 g D) 1.85 g E) 21.6 g

111. Which of the following statements are true about a sample of sulfur and a sample of oxygen if the two samples are of equal mass?

I. The number of electrons in the two samples is about the same.
II. The number of protons in the two samples is about the same.
III. The number of atoms in the two samples is about the same.
IV. There are roughly twice as many sulfur atoms as oxygen atoms.
V. There are roughly twice as many oxygen atoms as sulfur atoms.