Chapter 3: Mass Relationships in Chemical Reactions

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.
   Ans: E Category: Easy Section: 3.1

2. There are two stable isotopes of chlorine: chlorine-35, with a mass of 34.968853 amu; and chlorine-37, with a mass of 36.965903. Given that the average atomic mass of a chlorine atom is 35.45 amu, which of the following statements is true?
   A) Chlorine contains almost exclusively of $^{35}_{17}Cl$, with very little $^{37}_{17}Cl$.
   B) Chlorine contains more $^{35}_{17}Cl$ than $^{37}_{17}Cl$.
   C) Chlorine contains roughly equal amounts of $^{35}_{17}Cl$ and $^{37}_{17}Cl$.
   D) Chlorine contains more $^{37}_{17}Cl$ than $^{35}_{17}Cl$.
   E) Chlorine contains almost exclusively of $^{37}_{17}Cl$, with very little $^{35}_{17}Cl$.
   Ans: B Category: Easy Section: 3.1

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.
   Ans: D Category: Easy Section: 3.1

4. An atom of bromine has a mass about four times greater than that of an atom of neon. How many grams of neon will contain the same number of atoms as 1,000 g of bromine?
   A) 4 g Ne B) 250 g Ne C) 400 g Ne D) 1,000 g Ne E) 4,000 g Ne
   Ans: B Category: Medium Section: 3.1

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
   Ans: A Category: Easy Section: 3.1

6. Boron obtained from borax deposits in Death Valley consists of two isotopes. They are boron-10 and boron-11 with atomic masses of 10.013 amu and 11.009 amu, respectively. The atomic mass of boron is 10.81 amu (see periodic table). Which isotope of boron is more abundant, boron-10 or boron-11?
   A) Cannot be determined from data given
   B) Neither, their abundances are the same.
   C) Boron-10
   D) Boron-11
   Ans: D Category: Medium Section: 3.1

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.
   Ans: E Category: Medium Section: 3.1

8. What is the average mass, in grams, of one potassium atom?
   A) 5.14×10^{-23} g
   B) 6.49×10^{-23} g
   C) 6.02×10^{-18} g
   D) 31.0 g
   E) 39.1 g
   Ans: B Category: Easy Section: 3.2

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
   Ans: C Category: Easy Section: 3.2

10. What is the average mass, in grams, of one arsenic atom?
   A) 5.48×10^{-23} g B) 33.0 g C) 74.9 g D) 1.24×10^{-22} g E) 8.04×10^{21} g
   Ans: D Category: Easy Section: 3.2

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.
   Ans: D Category: Medium Section: 3.2

12. The mass of 1.63×10^{21} silicon atoms is
   A) 2.71×10^{-23} g.
   B) 4.58×10^{22} g.
   C) 28.08 g.
   D) 1.04×10^{4} g.
   E) 7.60×10^{-2} g.
   Ans: E Category: Medium Section: 3.2

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
    Ans: D Category: Medium Section: 3.2

14. If 0.274 moles of a substance weighs 62.5 g, what is the molar mass of the substance, in units of g/mol?
    A) 2.28×10^{2} g/mol
    B) 1.71×10^{1} g/mol
    C) 4.38×10^{-3} g/mol
    D) 2.17×10^{2} g/mol
    E) none of these
    Ans: A Category: Easy Section: 3.2

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.
    Ans: E Category: Medium Section: 3.2

16. Which one of the following does *not* represent 1.00 mol of the indicated substance?
    A) 6.02×10^{23} C atoms
    B) 26.0 g Fe
    C) 12.01 g C
    D) 65.4 g Zn
    E) 6.02×10^{23} Fe atoms
    Ans: B Category: Medium Section: 3.2

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
    Ans: B Category: Medium Section: 3.2

18. How many silicon atoms are there in 1.00 g of silicon?
    A) 1 atom
    B) 0.0356 atoms
    C) 2.57×10^{23} atoms
    D) 2.14×10^{22} atoms
    E) 1.75×10^{25} atoms
    Ans: D Category: Medium Section: 3.2

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
    Ans: B Category: Easy Section: 3.2

20. Calculate the number of moles of xenon in 12.0 g of xenon.
    A) 1.00 mol
    B) 0.0457 mol
    C) 0.183 mol
    D) 7.62×10^{-3} mol
    E) 0.0914 mol
    Ans: E Category: Easy Section: 3.2

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
    Ans: D Category: Difficult Section: 3.2

22. A silver wire has a diameter of 0.500 mm. What length of this wire contains exactly 1.00 mol of silver? (density of Ag = 10.5 g/cm^3)
    A) 52.3 m B) 222 m C) 13.1 m D) 2.01 m E) 890 m
    Ans: A Category: Difficult Section: 3.2

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
    Ans: E Category: Difficult Section: 3.2

24. How many atoms are in 5.54 g of F_2?
    A) 6.02×10^{23} atoms
    B) 0.146 atoms
    C) 0.292 atoms
    D) 8.78×10^{22} atoms
    E) 1.76×10^{23} atoms
    Ans: E Category: Medium Section: 3.3

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
    Ans: A Category: Medium Section: 3.3

26. How many atoms are in 0.0728 g of PCl_3?
    A) 1.28×10^{21} atoms
    B) 4.38×10^{22} atoms
    C) 4.39×10^{21} atoms
    D) 3.19×10^{20} atoms
    E) 6.02×10^{24} atoms
    Ans: A Category: Medium Section: 3.3

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
    Ans: B Category: Easy Section: 3.3

28. How many moles of NH_3 are there in 77.5 g of NH_3?
    A) 0.220 mol
    B) 4.55 mol
    C) 14.0 mol
    D) 1.31×10^3 mol
    E) None of the above.
    Ans: B Category: Easy Section: 3.3

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
    Ans: A Category: Easy Section: 3.2

30. Which of the following samples contains the greatest number of atoms?
    A) 100 g of Pb
    B) 2.0 mole of Ar
    C) 0.1 mole of Fe
    D) 5 g of He
    E) 20 million O_2 molecules
    Ans: B Category: Medium Section: 3.2

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
    Ans: D Category: Easy Section: 3.3

32. Calculate the molecular mass of menthol, $C_{10}H_{20}O$.
    A) 156 amu B) 140 amu C) 29 amu D) 146 amu E) 136 amu
    Ans: A Category: Easy Section: 3.3

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
    Ans: C Category: Easy Section: 3.3

34. What is the molar mass of nicotine, $C_{10}H_{14}N_2$?
    A) 134 g/mol B) 148 g/mol C) 158 g/mol D) 210 g/mol E) 162 g/mol
    Ans: E Category: Easy Section: 3.3

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
    Ans: E Category: Easy Section: 3.3

36. Calculate the mass of 3.00 moles of CF_2Cl_2.
    A) 3.00 g B) 174 g C) 363 g D) 1.81×10^{24} g E) 40.3 g
    Ans: C Category: Easy Section: 3.3

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.
Ans: D Category: Medium Section: 3.3

38. Formaldehyde has the formula CH_2O. How many molecules are there in 0.11 g of formaldehyde?
A) 6.1×10^{-27} B) 3.7×10^{-3} C) 4 D) 2.2×10^{21} E) 6.6×10^{22}
Ans: D Category: Medium Section: 3.3

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
Ans: C Category: Medium Section: 3.3

40. How many moles of HCl are represented by 1.0×10^{19} HCl molecules?
A) 1.7×10^{-5} mol
B) 1.5×10^{-3} mol
C) 1.0×10^{19} mol
D) 36.5 mol
E) 6.02×10^{4} mol
Ans: A Category: Easy Section: 3.2

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
Ans: C Category: Medium Section: 3.3

42. How many moles of oxygen atoms are there in 10 moles of $KClO_3$?
A) 3 mol B) 3.3 mol C) 10 mol D) 30 mol E) 6.02×10^{24} mol
Ans: D Category: Easy Section: 3.3

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
Ans: B Category: Medium Section: 3.3

44. How many sulfur atoms are present in 25.6 g of $Al_2(S_2O_3)_3$?
A) 0.393 B) 6 C) 3.95×10^{22} D) 7.90×10^{22} E) 2.37×10^{23}
Ans: E Category: Medium Section: 3.3

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
    Ans: D Category: Medium Section: 3.3

46. How many moles of O atoms are in 25.7 g of $CaSO_4$?
    A) 0.189 mol
    B) 0.755 mol
    C) 4.00 mol
    D) 1.14×10^{23} mol
    E) 4.55×10^{23} mol
    Ans: B Category: Medium Section: 3.3

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}
    Ans: D Category: Medium Section: 3.3

48. How many moles of Cl atoms are there in 65.2 g $CHCl_3$?
    A) 0.548 mol B) 1.09 mol C) 3.3×10^{23} mol D) 1.64 mol E) 3.0 mol
    Ans: D Category: Medium Section: 3.3

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
    Ans: A Category: Medium Section: 3.3

50. How many grams of sulfur are there in 6.0 g of $Fe_2(SO_4)_3$?
    A) 2.40 g B) 0.48 g C) 6.00 g D) 0.92 g E) 1.44 g
    Ans: E Category: Medium Section: 3.3

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
    Ans: C Category: Medium Section: 3.3

52. How many grams of nitrogen are there in 7.5 g of $Ca(NO_3)_2$?
    A) 0.64 g B) 1.3 g C) 0.15 g D) 1.15 g E) 2.3 g
    Ans: B Category: Medium Section: 3.3

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.
    Ans: C Category: Easy Section: 3.3

54. Calculate the mass of 4.50 moles of chlorine gas, Cl_2.
    A) 6.34×10^{-2} g B) 4.5 g C) 15.7 g D) 160 g E) 319 g
    Ans: E Category: Easy Section: 3.3

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
Ans: B Category: Easy Section: 3.3

56. What is the mass of 0.20 mole of C_2H_6O (ethanol)?
A) 230 g B) 46 g C) 23 g D) 4.6 g E) None of these.
Ans: E Category: Easy Section: 3.3

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
Ans: B Category: Medium Section: 3.3

58. A mass spectrometer works by ionizing atoms or molecules, and then accelerating them past oppositely charged plates. The mass is obtained by
A) measuring the force of impact on a detecting screen, and then calculating the mass using force = mass × acceleration.
B) suspending the ions in an applied electric field, and then calculating mass by the setting the downward gravitational force equal to the upward electrostatic force.
C) measuring the magnitude of deflection as the ions pass through a magnetic field to obtain the charge-to-mass ratio, and then calculating the mass from that ratio.
D) measuring the time it takes for the ions to hit the detector at a known distance to calculate the acceleration, and then calculating mass from force = mass × acceleration.
Ans: C Category: Medium Section: 3.4

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
Ans: D Category: Medium Section: 3.6

60. The percent composition by mass of a compound is 76.0% C, 12.8% H, and 11.2% O. The molar mass of this compound is 284.5 g/mol. What is the molecular formula of the compound?
A) $C_{10}H_6O$ B) $C_9H_{18}O$ C) $C_{16}H_{28}O_4$ D) $C_{20}H_{12}O_2$ E) $C_{18}H_{36}O_2$
Ans: E Category: Medium Section: 3.6

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
Ans: B Category: Medium Section: 3.6

62. An organic thiol compound is 38.66% C, 9.73% H, and 51.61% S by mass. What is the empirical formula of this compound?
A) C_2H_6S B) C_3H_8S C) $C_4H_{10}S$ D) $C_4H_{12}S$ E) $C_5H_{14}S$
Ans: A Category: Medium Section: 3.6

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) $C_5H_{11}Cl$
Ans: A Category: Medium Section: 3.6

64. Which one of the following chemical reactions is balanced?
A) $HCl + KMnO_4 \rightarrow Cl_2 + MnO_2 + H_2O + KCl$
B) $HCl + KMnO_4 \rightarrow Cl_2 + MnO_2 + 2H_2O + KCl$
C) $2HCl + 2KMnO_4 \rightarrow Cl_2 + MnO_2 + 2H_2O + 2KCl$
D) $6HCl + 2KMnO_4 \rightarrow 2Cl_2 + 2MnO_2 + 4H_2O + 2KCl$
E) $8HCl + 2KMnO_4 \rightarrow 3Cl_2 + 2MnO_2 + 4H_2O + 2KCl$
Ans: E Category: Medium Section: 3.6

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
Ans: B Category: Medium Section: 3.7

66. What is the coefficient of H_2O when the following equation is properly balanced with smallest set of whole numbers?
___ Al_4C_3 + ___ $H_2O \rightarrow$ ___ $Al(OH)_3$ + ___ CH_4
A) 3 B) 4 C) 6 D) 12 E) 24
Ans: D Category: Medium Section: 3.7

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.
Ans: C Category: Medium Section: 3.7

68. When a chemical equation is balanced, it will have a set of whole number coefficients that cannot be reduced to smaller whole numbers. What is the coefficient for O_2 when the following combustion reaction of a hydrocarbon is balanced?
___ C_7H_{14} + ___ $O_2 \rightarrow$ ___ CO_2 + ___ H_2O
A) 42 B) 21 C) 11 D) 10 E) none of these
Ans: B Category: Medium Section: 3.7

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
Ans: D Category: Medium Section: 3.7

70. What is the coefficient of H_2SO_4 when the following equation is properly balanced with the smallest set of whole numbers?
___ $Ca_3(PO_4)_2$ + ___ H_2SO_4 → ___ $CaSO_4$ + ___ H_3PO_4
A) 3 B) 8 C) 10 D) 11 E) none of these
Ans: A Category: Medium Section: 3.7

71. Balance the equation below using the smallest set of whole numbers. What is the coefficient of H_2O?
___ $PCl_3(l)$ + ___ $H_2O(l)$ → ___ $H_3PO_3(aq)$ + ___ $HCl(aq)$
A) 1 B) 2 C) 3 D) 5 E) none of these
Ans: C Category: Medium Section: 3.7

72. What is the coefficient of O_2 when the following equation is properly balanced with the smallest set of whole numbers?
___ CH_3OH + ___ O_2 → ___ CO_2 + ___ H_2O
A) 1 B) 2 C) 3 D) 7 E) none of these
Ans: C Category: Medium Section: 3.7

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 → __ H_2SO_3 + __ HF
A) 4. B) 6. C) 7. D) 9. E) none of these.
Ans: D Category: Medium Section: 3.7

74. Balance the following equation using the smallest set of whole numbers, then add together the coefficients. Don't forget to count coefficients of one. The sum of the coefficients is
___ Cr + ___ H_2SO_4 → ___ $Cr_2(SO_4)_3$ + ___ H_2
A) 4. B) 9. C) 11. D) 13. E) 15.
Ans: B Category: Medium Section: 3.7

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 → ___ $Al_2(SO_4)_3$ + ___ H_2
A) 3. B) 5. C) 6. D) 9. E) 12.
Ans: D Category: Medium Section: 3.7

76. 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
___ CH_4 + ___ Cl_2 → ___ CCl_4 + ___ HCl
A) 4. B) 6. C) 8. D) 10. E) 12.
Ans: D Category: Medium Section: 3.7

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.
Ans: B Category: Medium Section: 3.9

78. Ammonia reacts with diatomic oxygen to form nitric oxide and water vapor:
$4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$
When 20.0 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.
Ans: A Category: Medium Section: 3.9

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.
Ans: A Category: Medium Section: 3.9

80. Vanadium(V) oxide reacts with calcium according to the chemical equation below. When 10.0 moles of V_2O_5 are mixed with 10.0 moles of Ca, which is the limiting reagent?
$V_2O_5(s) + 5Ca(l) \rightarrow 2V(l) + 5CaO(s)$
A) V_2O_5 B) Ca C) V D) CaO E) No reagent is limiting.
Ans: B Category: Medium Section: 3.9

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.
Ans: B Category: Medium Section: 3.9

82. How many grams of Cl_2 can be prepared from the reaction of 16.0 g of MnO_2 and 30.0 g of HCl according to the following chemical equation?
$MnO_2 + 4HCl \rightarrow MnCl_2 + Cl_2 + 2H_2O$
A) 0.82 g B) 5.8 g C) 13.0 g D) 14.6 g E) 58.4 g
Ans: C Category: Medium Section: 3.9

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
Ans: B Category: Medium Section: 3.9

84. Calculate the mass of FeS formed when 9.42 g of iron reacts with 8.50 g of sulfur according to the following reaction.
$Fe(s) + S(s) \rightarrow FeS(s)$
A) 17.9 g B) 87.9 g C) 26.0 g D) 14.8 g E) 1.91×10^{-3} g
Ans: D Category: Medium Section: 3.9

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
Ans: B Category: Medium Section: 3.9

86. Calculate the mass of excess reagent remaining at the end of the reaction in which 90.0 g of SO_2 are mixed with 100.0 g of O_2.
$2SO_2 + O_2 \rightarrow 2SO_3$
A) 11.5 g B) 22.5 g C) 67.5 g D) 77.5 g E) 400 g
Ans: D Category: Medium Section: 3.9

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
Ans: C Category: Medium Section: 3.9

88. How many grams of water could be made from 5.0 mol H_2 and 3.0 mol O_2?
A) 90. g B) 36 g C) 42 g D) 45 g E) 108 g
Ans: A Category: Medium Section: 3.9

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.
Ans: C Category: Medium Section: 3.9

90. What is the theoretical yield of vanadium, in moles, that can be produced by the reaction of 2.0 mole of V_2O_5 with 6.0 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) 2.4 mol E) 4.0 mol
Ans: D Category: Medium Section: 3.9

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
Ans: B Category: Medium Section: 3.9

92. What is the theoretical yield of vanadium that can be produced by the reaction of 40.0 g of V_2O_5 with 40.0 g of calcium based on the following chemical reaction?
$V_2O_5(s) + 5Ca(l) \rightarrow 2V(l) + 5CaO(s)$
A) 11.2 g B) 5.6 g C) 22.4 g D) 40.0 g E) 20.3 g
Ans: E Category: Medium Section: 3.9

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.
Ans: B Category: Medium Section: 3.9

94. What is the theoretical yield of aluminum that can be produced by the reaction of 60.0 g of aluminum oxide with 30.0 g of carbon according to the following chemical reaction?
$Al_2O_3 + 3C \rightarrow 2Al + 3CO$
A) 30.0 g B) 7.9 g C) 101.2 g D) 45.0 g E) 31.8 g
Ans: E Category: Medium Section: 3.9

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
Ans: D Category: Difficult Section: 3.6

96. A 0.8715 g sample of sorbic acid, a compound first obtained from the berries of a certain ash tree, is burned completely in oxygen to give 2.053 g of carbon dioxide and 0.5601 g of water. The empirical formula of sorbic acid is
A) CH_2O B) C_3H_4O C) CH_4O_3 D) $C_3H_4O_2$ E) $C_2H_4O_2$
Ans: B Category: Difficult Section: 3.6

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) $C_4H_{10}O_2$
Ans: C Category: Easy Section: 3.6

98. Washing soda is a hydrate of sodium carbonate. Elemental analysis of a sample of washing soda gave 4.20% C and 7.05% H. What is the formula for washing soda?
A) $Na_2CO_3 \cdot 2H_2O$
B) $Na_2CO_3 \cdot 4H_2O$
C) $Na_2CO_3 \cdot 6H_2O$
D) $Na_2CO_3 \cdot 8H_2O$
E) $Na_2CO_3 \cdot 10H_2O$
Ans: E Category: Difficult Section: 3.6

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%
Ans: C Category: Difficult Section: 3.10

100. One way of obtaining pure sodium carbonate is through the decomposition of the mineral trona, $Na_5(CO_3)_2(HCO_3) \cdot 2H_2O$, as shown in the following reaction:
$2Na_3(CO_3)(HCO_3) \cdot 2H_2O(s) \rightarrow 3Na_2CO_3(s) + CO_2(g) + 5H_2O(g)$
When 15 metric ton (1×10^3 kg) of trona is decomposed, 11 metric ton of Na_2CO_3 is recovered. What is the percent yield of this reaction? (1 metric ton = 10^3 kg)
A) 95% B) 73% C) 65% D) 42% E) 13%
Ans: A Category: Difficult Section: 3.10

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
Ans: B Category: Difficult Section: 3.10

102. 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 75%, what mass of aluminum metal can be produced from the reaction of 1.65×10^6 of aluminum oxide with 1.50×10^6 g of carbon?
A) 1.6×10^5 g
B) 3.3×10^5 g
C) 6.6×10^5 g
D) 8.7×10^5 g
E) 1.7×10^6 g
Ans: C Category: Difficult Section: 3.10

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
Ans: E Category: Difficult Section: 3.10

104. A method for producing pure copper metal involves the reaction of copper(I) sulfide with oxygen gas to give copper metal and sulfur dioxide. Suppose the yield of this reaction is 87%. What mass of a copper ore consisting of 46% copper(I) sulfide must be mined in order to produce 1.0×10^3 kg (1.0 metric ton) of copper metal?
A) 1.4×10^3 kg
B) 3.2×10^3 kg
C) 1.3×10^3 kg
D) 1.5×10^3 kg
E) 8.0×10^3 kg
Ans: B Category: Difficult Section: 3.10

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) $\frac{1}{2}$ E) cannot be determined
Ans: B Category: Medium Section: 3.7

106. Aluminum hydroxide reacts with nitric acid to form aluminum nitrate and water. What mass of water can be formed by the reaction of 15.0 g of aluminum hydroxide with excess nitric acid?
A) 1.15 g B) 3.46 g C) 45.0 g D) 6.14 g E) 10.4 g
Ans: E Category: Medium Section: 3.8

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
Ans: C Category: Medium Section: 3.8

108. Liquid heptane, C_7H_{16} , burns in oxygen gas to yield carbon dioxide and water. What mass of carbon dioxide is produced when 15.0 mL of heptane burns completely? (density of heptane = 0.6838 g/mL)
A) 46.1 g B) 71.8 g C) 4.49 g D) 6.59 g E) 31.5 g
Ans: E Category: Medium Section: 3.8

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
Ans: A Category: Medium Section: 3.8

110. Liquid heptane, C_7H_{16}, burns in oxygen gas to yield carbon dioxide and water. What is the minimum mass of oxygen required for the complete reaction of 25.5 mL of heptane? (density of heptane = 0.6838 g/mL)
A) 8.14 g B) 89.6 g C) 61.3 g D) 30.6 g E) 5.57 g
Ans: C Category: Medium Section: 3.8

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.
Ans: I, II, and V
Category: Difficult Section: 3.1

112. Nickel has a lower atomic mass than cobalt, even though it has a higher atomic number. One possible explanation is that one of the average atomic masses was miscalculated. In the case of cobalt, there is only one isotope: 100% ^{59}Co at a mass of 58.9332 amu. For nickel, however, there are five isotopes as given in the table.

isotope	mass (amu)	abundance
^{58}Ni	57.9354	67.76%
^{60}Ni	59.9308	26.16%
^{61}Ni	60.9311	1.25%
^{62}Ni	61.9283	3.66%
^{64}Ni	63.9280	1.16%

A. Using the data in the table, calculate the average atomic mass for nickel.

B. Is the atomic mass for nickel in your periodic table correct?

C. Regardless of your answer to part B, how else could you explain the observation that the atomic mass of nickel is less than the mass of cobalt, even though it has the higher atomic number?

Ans: A. 58.70 amu
B. yes
C. Cobalt has 27 protons and 32 neutrons per atom. While nickel has one more proton than cobalt, it has on average greater enough fewer neutrons than cobalt to lower the average atomic mass of nickel to be less than that of cobalt.

Category: Difficult Section: 3.1

113. How many moles of aluminum are present in an Al cylinder with a mass of 15 g?
Ans: 0.56 mole
Category: Easy Section: 3.2

114. How many moles of iron are present in an iron cylinder that weighs 25 g?
Ans: 0.45 mole
Category: Easy Section: 3.2

115. Calculate the molecular mass, in g/mol, of H_2SO_4.
Ans: 98.09 g/mol
Category: Easy Section: 3.3

116. Calculate the molecular mass, in g/mol, of P_4O_{10}.
Ans: 283.9 g/mol
Category: Easy Section: 3.3

117. Calculate the molecular mass, in g/mol, of $C_6H_{12}O_6$.
Ans: 180.2 g/mol
Category: Easy Section: 3.3

118. How many ICl_3 molecules are present in 1.75 kg of ICl_3?
Ans: 4.52×10^{24}
Category: Medium Section: 3.3

119. How many Mg atoms are present in 170 g of Mg?
Ans: 4.2×10^{24}
Category: Easy Section: 3.2

120. Calculate the mass of 3.7 moles of Br_2.
Ans: 590 g
Category: Easy Section: 3.3

121. Calculate the volume of 0.15 mole of Br_2. The density of Br_2 is 3.12 g/mL.
Ans: 7.7 mL
Category: Medium Section: 3.3

122. A chemistry student determined the empirical formula for titanium sulfide (Ti_xS_y). To do so, she reacted titanium with excess sulfur in a crucible, and recorded the following data:

Weight of crucible	11.120 g
Weight of titanium	8.820 g
Weight of crucible and product	31.700 g

What is the empirical formula of titanium sulfide?
Ans: TiS_2
Category: Medium Section: 3.6

123. A chemistry student determined the empirical formula for tungsten oxide (W_xO_y). To do so, he heated tungsten with oxygen in a crucible. The data that he recorded are shown below:

Weight of crucible	11.120 g
Weight of tungsten	8.820 g
Weight of crucible and product	22.998 g

What is the empirical formula of tungsten oxide?
Ans: WO_4
Category: Medium Section: 3.6

124. A compound with a percent composition by mass of 87.5% N and 12.5% H was recently discovered. What is the empirical formula for this compound?
Ans: NH_2
Category: Medium Section: 3.6

125. Define a *mole*.
Ans: An Avogadro's number of a specific entity, such as an atom or molecule
Category: Easy Section: 3.2

126. If 0.66 mole of a substance has a mass of 99 g, what is the molecular mass of the substance?
Ans: 150 g
Category: Medium Section: 3.2

127. Calculate the molecular mass of ethylene glycol, $C_2H_6O_2$, a compound frequently used as automobile antifreeze.
Ans: 62.1 g
Category: Easy Section: 3.3

128. Calculate the percent composition by mass of sodium in Na_2CO_3.
Ans: 43.4%
Category: Medium Section: 3.5

129. Calculate the percent composition by mass of carbon in Na_2CO_3.
Ans: 11.3%
Category: Medium Section: 3.5

130. Calculate the percent composition by mass of oxygen in Na_2CO_3.
Ans: 45.3%
Category: Medium Section: 3.5

131. A 0.600 g sample of a compound of arsenic and oxygen was found to contain 0.454 g of arsenic. What is the empirical formula of the compound?
Ans: As_2O_3
Category: Medium Section: 3.6

132. A sample of unknown ore was analyzed and found to contain 12.7% Al, 19.7% N, and 67.6% O. What is the empirical formula of this ore?
Ans: AlN_3O_9
Category: Medium Section: 3.6

133. Phosgene, a poisonous gas used during WWI, is composed of 12.1% C, 16.2% O, and 71.1% Cl. What is the empirical formula of phosgene?
Ans: $COCl_2$
Category: Medium Section: 3.6

134. What percent by mass of oxygen is present in carbon monoxide, CO?
Ans: 57%
Category: Medium Section: 3.5

135. Balance the following chemical equation:
$NaNO_3 \rightarrow NaNO_2 + O_2$
Ans: $2NaNO_3 \rightarrow 2NaNO_2 + O_2$
Category: Medium Section: 3.7

136. Balance the following chemical equation:
$NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$
Ans: $2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$
Category: Medium Section: 3.7

137. Balance the following chemical equation:
$H_2 + N_2 \rightarrow NH_3$
Ans: $3H_2 + N_2 \rightarrow 2NH_3$
Category: Medium Section: 3.7

138. Balance the following chemical equation:
$C_4H_{10} + O_2 \rightarrow CO_2 + H_2O$
Ans: $2C_4H_{10} + 13\ O_2 \rightarrow 8CO_2 + 10H_2O$
Category: Medium Section: 3.7

139. Balance the following chemical equation:
$C_3H_6O + O_2 \rightarrow CO_2 + H_2O$
Ans: $C_3H_6O + 4O_2 \rightarrow 3CO_2 + 3H_2O$
Category: Medium Section: 3.7

140. Balance the following chemical equation:
$C + Fe_2O_3 \rightarrow Fe + CO$
Ans: $3C + Fe_2O_3 \rightarrow 2Fe + 3CO$
Category: Medium Section: 3.7

141. Balance the following chemical equation:
$P_4O_{10} + H_2O \rightarrow H_3PO_4$
Ans: $P_4O_{10} + 6H_2O \rightarrow 4H_3PO_4$
Category: Medium Section: 3.7

142. Balance the following chemical equation:
$Al(s) + Co(NO_3)_2(aq) \rightarrow Al(NO_3)_3(aq) + Co(s)$
Ans: $2Al(s) + 3Co(NO_3)_2(aq) \rightarrow 2Al(NO_3)_3(aq) + 3Co(s)$
Category: Medium Section: 3.7

143. Refer to the (unbalanced) equation $CS_2 + CaO \rightarrow CO_2 + CaS$. How many grams of CaS are produced if 53 g of CO_2 are produced?
Ans: 170 g
Category: Medium Section: 3.8

144. Refer to the (unbalanced) equation $CS_2 + CaO \rightarrow CO_2 + CaS$. How many grams of CaO are required to react completely with 38 g of CS_2?
Ans: 56 g
Category: Medium Section: 3.8

145. How many grams of silver nitrate are necessary to react completely with 7.000 moles of copper?
$Cu + 2\ AgNO_3 \rightarrow Cu(NO_3)_2 + 2\ Ag$
Ans: 2379 g
Category: Medium Section: 3.8

146. What mass of sodium nitrate would be produced from the complete reaction of 1.00 mol of lead nitrate?
$2\ NaCl + Pb(NO_3)_2 \rightarrow 2\ NaNO_3 + PbCl_2$
Ans: 170. g
Category: Medium Section: 3.8

147. What is the minimum mass of sulfur dioxide necessary to produce 200. g of sulfuric acid in the following reaction?
$2SO_2 + O_2 + 2H_2O \rightarrow 2H_2SO_4$
Ans: 131 g
Category: Medium Section: 3.8

148. What is the minimum mass of oxygen gas necessary to produce 200. g of sulfuric acid in the following reaction?
$2SO_2 + O_2 + 2\ H_2O \rightarrow 2H_2SO_4$
Ans: 32.6 g
Category: Medium Section: 3.8

149. What is the minimum mass of water necessary to produce 200. g of sulfuric acid in the following reaction?
$2SO_2 + O_2 + 2H_2O \rightarrow 2H_2SO_4$
Ans: 36.7 g
Category: Medium Section: 3.8

150. How many moles of phosphine (PH_3) are produced for every 4.0 moles of hydrogen that react according to the chemical equation below?
$3H_2 + P_2 \rightarrow 2PH_3$
Ans: 2.7 moles
Category: Medium Section: 3.8

151. Calculate the mass of sodium chlorate that must be decomposed to form 6.5 g of oxygen.
$2NaClO_3(s) \rightarrow 2NaCl(s) + 3O_2(g)$
Ans: 14 g
Category: Medium Section: 3.8

152. What is the theoretical yield of PI_3 if 48.0 g of I_2 are reacted with an excess of phosphorus according to the following chemical equation?
$2P(s) + 3I_2(s) \rightarrow 2PI_3(s)$
Ans: 51.9 g
Category: Medium Section: 3.8

153. Phosphorus reacts with iodine as shown in the chemical reaction below. What is the percent yield of the reaction if 28.2 g PI_3 is obtained from the reaction of 48.0 g of I_2 with excess phosphorus?
$2P(s) + 3I_2(s) \rightarrow 2PI_3(s)$
Ans: 54.3%
Category: Medium Section: 3.10

154. What is the limiting reagent when 27.0 g of P and 68.0 g of I_2 react according to the following chemical equation?
$2P(s) + 3I_2(s) \rightarrow 2PI_3(s)$
Ans: I_2
Category: Medium Section: 3.9

155. Determine the number of moles of water produced by the reaction of 155 g of ammonia and 356 g of oxygen.
$4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$
Ans: 13.7 moles
Category: Medium Section: 3.9

156. What is the theoretical yield of PI_3 from the reaction of 27.0 g of P and 68.0 g of I_2?
$2P(s) + 3I_2(s) \rightarrow 2PI_3(s)$
Ans: 73.5 g
Category: Medium Section: 3.10

157. When a 0.860 g sample of an organic compound containing C, H, and O was burned completely in oxygen, 1.64 g of CO_2 and 1.01 g of H_2O were produced. What is the empirical formula of the compound?
Ans: C_2H_6O
Category: Difficult Section: 3.6

158. When a 0.952 g sample of an organic compound containing C, H, and O is burned completely in oxygen, 1.35 g of CO_2 and 0.826 g of H_2O are produced. What is the empirical formula of the compound?
Ans: CH_3O
Category: Difficult Section: 3.6

159. The percent composition by mass of tartaric acid is: 32.01% C, 4.03% H, and 63.96% O. Given that the molecular mass of tartaric acid is 150 amu, determine its molecular formula.
Ans: $C_4H_6O_6$
Category: Medium   Section: 3.6

160. Oxidation of a hydrocarbon gave a product composed of carbon, hydrogen, and oxygen. The product that was purified and sent off for elemental analysis giving the following mass percents: 68.85% C and 4.95% H. Determine the empirical formula of this compound.
Ans: $C_7H_6O_2$
Category: Medium   Section: 3.6

161. Commonly used gases in the laboratory are generally obtained from pressurized metal gas cylinders, but for small amounts of occasionally used gases, it is sometimes easier just to prepare them chemically as needed. For example, nitrogen monoxide, NO(g), can be prepared in the lab by the following chemical reaction:
$3Cu(s) + 8HNO_3(aq) \rightarrow 2NO(g) + 3Cu(NO_3)_2(aq) + 4H_2O(l)$
If 5.0 g of copper metal was added to an aqueous solution containing 2.5 moles of HNO_3, how many moles of NO(g) would be produced, assuming a 100% yield.
Ans: 0.052 mole NO
Category: Medium   Section: 3.9

162. Commonly used gases in the laboratory are generally obtained from pressurized metal gas cylinders, but for small amounts of occasionally used gases, it is sometimes easier just to prepare them chemically as needed. For example, nitrogen monoxide, NO(g), can be prepared in the lab by the following chemical reaction:
$3Cu(s) + 8HNO_3(aq) \rightarrow 2NO(g) + 3Cu(NO_3)_2(aq) + 4H_2O(l)$
If 15 g of copper metal was added to an aqueous solution containing 6.0 moles of HNO_3, how many moles of NO(g) would be produced, assuming a 75% yield.
Ans: 0.12 mole NO
Category: Medium   Section: 3.10

163. Common gases used in laboratories are generally obtained from pressurized metal gas cylinders, but for small amounts of occasionally-used gases, it is sometimes easier just to prepare them chemically. For example, oxygen gas can be prepared by heating $KMnO_4(s)$ according to the following chemical reaction:
$2KMnO_4(s) \rightarrow K_2MnO_4(s) + MnO_2(s) + O_2(g)$
How many grams of $KMnO_4$ would you need to produce 0.27 moles of O_2, assuming 100% conversion? The molar mass of $KMnO_4$ is 158.034 g/mol.
Ans: 85 g $KMnO_4$ required
Category: Medium   Section: 3.8

164. Common gases used in laboratories are generally obtained from pressurized metal gas cylinders, but for small amounts of occasionally-used gases, it is sometimes easier just to prepare them chemically. For example, oxygen gas can be prepared by heating $KMnO_4(s)$ according to the following chemical reaction:
$2KMnO_4(s) \rightarrow K_2MnO_4(s) + MnO_2(s) + O_2(g)$
The above procedure was carried out starting with 93.2 g of $KMnO_4$, and it was later determined that all of the $KMnO_4$ reacted according to the above equation except 11.7 g. What was the percent yield for the reaction?
Ans: 87.4% yield
Category: Medium Section: 3.10

165. In the Haber process, hydrogen gas reacts with nitrogen gas to produce ammonia. How many kilograms of hydrogen would be required to react completely with 1.0 kg of nitrogen, and how many kilograms of ammonia would be formed?
Ans: 0.22 kg hydrogen required, 1.2 kg ammonia produced
Category: Medium Section: 3.9

166. Ammonium nitrate decomposes to give dinitrogen monoxide and water as shown in the following reaction:
$NH_4NO_3 \rightarrow N_2O + 2H_2O$
If a 108 g sample of NH_4NO_3 decomposes to give 23 g of $N_2O(g)$, what percent of the original sample remains?
Ans: 61% remains
Category: Medium Section: 3.10

167. Ferrocene, $Fe(C_5H_5)_2(s)$, can be prepared by reacting 3.0 g of $FeCl_2(s)$ with an equal mass of cyclopentadiene, $C_5H_6(l)$, and an excess of KOH, as shown in the following reaction
$FeCl_2 + 2C_5H_6 + 2KOH \rightarrow FeC_{10}H_{10} + 2H_2O$
A. What is the limiting reagent in this procedure? B. Based on your answer to part A, what mass of $Fe(C_5H_5)_2$ could theoretically be formed? C. A student who carried out this reaction obtained 2.7 g of ferrocene. What was the percent yield for this reaction?
Ans: A. C_5H_6 is limiting
B. 4.2 g of ferrocene
C. 64% yield
Category: Medium Section: 3.10

168. Acetylene gas, HCCH(g), can be generated in the laboratory by adding calcium carbide to excess water, as shown in the following reaction
$CaC_2(s) + H_2O(l) \rightarrow HCCH(g) + CaO(s)$
How many grams of CaC_2 would be required to generate 0.20 moles of HCCH(g)?
Ans: 13 g of CaC_2 would be required
Category: Medium Section: 3.8