Concept Review Questions

Stoichiometry

1. One amu is defined as
   A) the mass of a proton.
   B) 1/12 the mass of an atom of ^{12}C.
   C) the mass of an atom of ^{1}H.
   D) 1/20 the mass of an atom of ^{20}Ne.
   E) 1/16 the mass of an atom of ^{16}O.

2. In the modern periodic table, the order in which the elements are placed is based on
   A) atomic mass.
   B) mass number.
   C) atomic number.
   D) number of electron
   E) number of neutron

3. Lithium forms compounds which are used in dry cells and storage batteries and in high-temperature lubricants. It has two naturally occurring isotopes, ^{6}Li (isotopic mass = 6.015121 amu) and ^{7}Li (isotopic mass = 7.016003 amu). Lithium has an atomic mass of 6.9409 amu. What is the percent abundance of lithium-6?

   A) 92.50% B) 86.66% C) 46.16% D) 7.503% E) 6.080%

4. Silicon, which makes up about 25% of Earth's crust by mass, is used widely in the modern electronics industry. It has three naturally occurring isotopes, ^{28}Si, ^{29}Si, and ^{30}Si. Calculate the atomic mass of silicon.

Isotope	Isotopic Mass (amu)	Abundance %
^{28}Si	27.976927	92.23
^{29}Si	28.976495	4.67
^{30}Si	29.973770	3.10

   A) 29.2252 amu
   B) 28.9757 amu
   C) 28.7260 amu
   D) 28.0855 amu
   E) 27.9801 amu

5. 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

6. What is the mass, in grams, of one copper atom?

   A. 1.055×10^{-22} g B. 63.55 g C. 1 amu
   D. 1.66×10^{-24} g E. 9.476×10^{21} g

7. 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.

8. 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

9. Calcium fluoride, CaF_2, is a source of fluorine and is used to fluoridate drinking water. Calculate its molar mass.

A) 118.15 g/mol D) 59.08 g/mol
B) 99.15 g/mol E) 50.01 g/mol
C) 78.07 g/mol

10. Calculate the molar mass of tetraphosphorus decaoxide, P_4O_{10}, a corrosive substance which can be used as a drying agent.

A) 469.73 g/mol D) 139.88 g/mol
B) 283.89 g/mol E) 94.97 g/mol
C) 190.97 g/mol

11. Calculate the molar mass of rubidium carbonate, Rb_2CO_3.

A) 340.43 g/mol D) 145.47 g/mol
B) 255.00 g/mol E) 113.48 g/mol
C) 230.94 g/mol

12. Calculate the molar mass of $(NH_4)_3AsO_4$.

A) 417.80 g/mol D) 156.96 g/mol
B) 193.03 g/mol E) 108.96 g/mol
C) 165.02 g/mol

13. Calculate the molar mass of $Ca(BO_2)_2 \cdot 6H_2O$.

A) 273.87 g/mol D) 174.89 g/mol
B) 233.79 g/mol E) 143.71 g/mol
C) 183.79 g/mol

14. Magnesium fluoride is used in the ceramics and glass industry. What is the mass of 1.72 mol of magnesium fluoride?

A) 43.3 g B) 62.3 g C) 74.5 g D) 92.9 g E) 107 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. is none of these.

16. Sodium bromate is used in a mixture which dissolves gold from its ores. Calculate the mass in grams of 4.68 mol of sodium bromate.
A) 706 g B) 482 g C) 383 g D) 32.2 g E) 0.0310 g

17. What is the mass in grams of 0.250 mol of the common antacid calcium carbonate?
A) 4.00×10^{2} g B) 25.0 g C) 17.0 g
D) 4.00×10^{-2} g E) 2.50×10^{-3}g

18. Calculate the number of moles in 17.8 g of the antacid magnesium hydroxide, $Mg(OH)_2$.
A) 3.28 mol B) 2.32 mol C) 0.431 mol
D) 0.305 mol E) 0.200 mol

19. Phosphorus pentachloride, PCl_5, a white solid that has a pungent, unpleasant odor, is used as a catalyst for certain organic reactions. Calculate the number of moles in 38.7 g of PCl_5.
A) 5.38 mol B) 3.55 mol C) 0.583 mol
D) 0.282 mol E) 0.186 mol

20. Aluminum oxide, Al_2O_3, is used as a filler for paints and varnishes as well as in the manufacture of electrical insulators. Calculate the number of moles in 47.51 g of Al_2O_3.
A) 2.377 mol B) 2.146 mol C) 1.105 mol
D) 0.4660 mol E) 0.4207 mol

21. Which of the following samples has the most moles of the compound?
A) 50.0 g of Li_2O
B) 75.0 g of CaO
C) 200.0 g of Fe_2O_3
D) 50.0 g of CO_2
E) 100.0 g of SO_3

22. 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

23. 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

24. 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

25. Calculate the number of oxygen atoms in 29.34 g of sodium sulfate, Na_2SO_4.

A) 1.244×10^{23} O atoms D) 2.915×10^{24} O atoms
B) 4.976×10^{23} O atoms E) 1.166×10^{25} O atoms
C) 2.409×10^{24} O atoms

26. Which of these quantities 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

27. 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

28. Potassium dichromate, $K_2Cr_2O_7$, is used in tanning leather, decorating porcelain, and water proofing fabrics. Calculate the number of chromium atoms in 78.82 g of $K_2Cr_2O_7$.

A) 9.490×10^{25} Cr atoms D) 3.227×10^{23} Cr atoms
B) 2.248×10^{24} Cr atoms E) 1.613×10^{23} Cr atoms
C) 1.124×10^{24} Cr atoms

29. Sulfur trioxide can react with atmospheric water vapor to form sulfuric acid that falls as acid rain. Calculate the mass in grams of 3.65×10^{20} molecules of SO_3.

A) 6.06×10^{-4} g B) 2.91×10^{-2} g C) 4.85×10^{-2} g
D) 20.6 g E) 1650 g

30. Calculate the mass in grams of 8.35×10^{22} molecules of CBr_4.

A) 0.0217 g B) 0.139 g C) 7.21 g
D) 12.7 g E) 46.0 g

31. The number of hydrogen atoms in 0.050 mol of $C_3H_8O_3$ is

A) 3.0×10^{22} H atoms. D) 4.8×10^{23} H atoms.
B) 1.2×10^{23} H atoms. E) none of the above.
C) 2.4×10^{23} H atoms.

Solution and Concentration units

32) A solution is prepared by dissolving 2 g of KCl in 100 g of H_2O. In this solution, H_2O is the _____.

a. solute. b. solvent. c. solution.
d. solid. e. ionic compound.

Percent solution

33) The mass/mass percent concentration refers to____.
A) grams of solute in 1 kg of solvent.
B) grams of solute in 1 kg of solution.
C) grams of solute in 100 g of solvent.
D) grams of solute in 100 g of solution.
E) grams of solvent in 100 g of solution.

34) The mass/volume percent concentration refers to
A) grams of solute in 1 L of solvent.
B) grams of solute in 1 L of solution.
C) grams of solute in 100 mL of solvent.
D) grams of solute in 100 mL of solution.
E) grams of solvent in 100 mL of solution.

35) What is the concentration, in %(weight/weight), of a solution prepared from 50.0 g NaCl and 150.0 g of water?
A) 0.250% B) 33.3% C) 40.0% D) 25.0% E) 3.00%

36) Rubbing alcohol is 70.% isopropyl alcohol by volume. How many mL of isopropyl alcohol are in a 1 pint (473 mL) container?
A) 70. mL B) 0.15 mL C) 680 mL D) 470 mL E) 330 mL

37) What is the concentration, in m/v%, of a solution prepared from 50. g NaCl and 2.5 L of water? (Assume that the addition of NaCl does not change the volume of the solution.)
A) 5.0% B) 2.0% C) 0.020%
D) 0.050% E) 20.%

38) How many grams of glucose are needed to prepare 400. mL of a 2.0%(m/v) glucose solution?
A) 800. g B) 0.0050 g C) 8.0 g
D) 2.0 g E) 200. g

39) A patient needs to receive 85 grams of glucose every 12 hours. What volume of a 5.0%(m/v) glucose solution needs to be administered to the patient each 12 hours?
A) 1700 mL B) 60 mL C) 6000 mL
D) 17 mL E) 204 mL

40) What volume (mL) of a 15% (m/v) NaOH solution contains 120 g NaOH?
A) 18 mL B) 0.13 mL C) 13 mL
D) 120 mL E) 8.0×10^2 mL

41) How many milliliters of a 25% (m/v) NaOH solution would contain 75 g of NaOH?
A) 25 mL B) 75 mL C) 33 mL
D) 19 mL E) 3.0×10^2 mL

Molarity

42) The molarity (M) of a solution refers to
A) moles of solute/L of solution.
B) moles of solute/L of solvent.
C) moles of solute/100 mL of solution.
D) grams of solute/100 mL of solution.
E) grams of solute/L of solution.

43) What is the molarity of a solution that contains 17 g of NH_3 in 0.50 L of solution?
A) 34 M B) 2.0 M C) 0.50 M
D) 0.029 M E) 1.0 M

44) What is the molarity of a solution that contains 3.25 moles of $NaNO_3$ in 250. mL of solution?
A) 3.25 M B) 6.50 M C) 0.0130 M
D) 13.0 M E) 2.60 M

45) What is the molarity of a solution containing 5.0 moles of KCl in 2.0 L of solution?
A) 2.5 M B) 1.0 M C) 5.0 M
D) 10. M E) 2.0 M

46) What is the molarity of a solution which contains 58.5 g of sodium chloride dissolved in 0.500 L of solution?
A) 0.500 M B) 1.00 M C) 1.50 M
D) 2.00 M E) 4.00 M

47) How many moles of $CaCl_2$ are in 250 mL of a 3.0 M of $CaCl_2$ solution?
A) 750 moles B) 1.3 moles C) 83 moles
D) 0.75 mole E) 3.0 moles

48) What volume of a 1.5 M KOH solution is needed to provide 3.0 moles of KOH?
A) 3.0 L B) 0.50 L C) 2.0 L
D) 4.5 L E) 0.22 L

49) How many grams of NaOH (***MW*** = 40.0) are there in 500.0 mL of a 0.175 M NaOH solution?
A) 2.19×10^{-3} B) 114 C) 14.0
D) 3.50 E) 3.50×10^{3}

50) How many grams of CH_3OH must be added to water to prepare 150 mL of a solution that is 2.0 M CH_3OH ?
A) 9.6×10^{3} B) 4.3×10^{2} C) 2.4
D) 9.6 E) 4.3

51) How many moles of Co^{2+} are present in 0.200 L of a 0.400 M solution of CoI_2 ?
A) 2.00 B) 0.500 C) 0.160
D) 0.0800 E) 0.0400

52) **How many moles of K^+ are present in 343 mL of a 1.27 M solution of K_3PO_4 ?
A) 0.436 B) 1.31 C) 0.145
D) 3.70 E) 11.1

Dilution

53) During the process of diluting a solution to a lower concentration,
A) the amount of solute does not change.
B) the amount of solvent does not change.
C) there is more solute in the concentrated solution.
D) the volume of the solution does not change.
E) water is removed from the concentrated solution.

54) An aqueous ethanol solution (400 mL) was diluted to 4.00 L, giving a concentration of 0.0400 M. The concentration of the original solution was _____ M.
A) 0.400 B) 0.200 C) 2.00 D) 1.60 E) 4.00

55) The concentration (M) of an aqueous methanol produced when 0.200 L of a 2.00 M solution was diluted to 0.800 L is _____ .
A) 0.800 B) 0.200 C) 0.500
D) 0.400 E) 8.00

56) When 200. mL of water are added to 100. mL of 12% KCl solution the final concentration of KCl is (Assume the volumes add.)
A) 12%. B) 4.0%. C) 36%.
D) 6.0%. E) 8.0%.

57) What is the molarity of a KCl solution made by diluting 75.0 mL of a 0.200 M solution to a final volume of 100. mL?
A) 0.267 M B) 0.150 M C) 0.200 M
D) 6.67 M E) 0.100 M

58) What volume of 2.5% (m/v) KOH can be prepared from 125 mL of a 5.0% KOH solution?
A) 0.0040 mL B) 63 mL C) 0.10 mL
D) 125 mL E) 250 mL

59) What volume of 0.10 M NaOH can be prepared from 250. mL of 0.30 M NaOH?
A) 0.075 L B) 0.25 L C) 0.75 L
D) 0.083 L E) 750 L

60) What volume of a 2.00 M KCl solution is required to prepare 500. mL of a 0.100 M KCl solution?
A) 0.0400 mL B) 25.0 mL C) 2.00 mL
D) 1.00×10^4 mL E) 5.00×10^2 mL

61) When 135 mL of 18.4 M H_2SO_4 is diluted to 350 mL, the resulting molarity of the H_2SO_4 solution is:
A. 4.77 M B. 2.59 M C. 7.1 M
D. 47.7 M E. 0.71 M

62) What is the new mass/volume (m/v)% of a KOH solution that is prepared by diluting 110 mL of a 6% (m/v) KOH solution to 330 mL?
A) 2% B) 1% C) 6%
D) 12% E) 18%

63) **If 50.0 mL of 0.150 M magnesium bromide ($MgBr_2$)is combined with 200 mL of 0.110 M sodium bromide (NaBr) what is the molarity of the bromide ion in the resulting solution? (assume volumes are additive)
A) 0.074 M B) 0.26 M C) 0.0118 M
D) 0.148 M E) 0.52 M

Molality

64) The **molality** (*m*) of a solution of ethyl alcohol, C_2H_5OH, in water is 0.96 mol/kg. How many grams of alcohol are dissolved in 5.98 kg of water?
A) 7.40 g B) 287.2 g C) 74.1 g
D) 264.7 g E) 740 g

65) What is the molality of a solution which contains 38.0 g of cane sugar, $C_{12}H_{22}O_{11}$, dissolved in 175 g of water?
A) 0.514 mol/kg B) 635.0 mol/kg C) 0.217 mol/kg
D) 0.635 mol/kg E) 217.0 mol/kg

66) What is the percent KCl by mass in a 3.00 molal solution?
A) 0.300% B) 12.5% C) 18.3%
D) 30.0% E) none of the above

Calculating Molarity from Percent Solutions

67) Calculate the molar concentration of a sulfuric acid solution of density 1.398 g/cm^3, containing 23.0 % H_2SO_4 by weight.
A. 5.96 M B. 0.328 M C. 0.596 M
D. 3.28 M E. none of the above

68) What is the molarity of a solution that is 46% by mass perchloric acid ($HClO_4$)? The density of the solution is 1.23 g/mL.
A) 5.6 M B) 1.2 M C) 1.7 M
D) 7.9 M E) none of the above

69) How many grams of ethanol (C_2H_6O) are in a 250 mL sample of a solution which is 20% ethanol by volume in water. The density of ethanol is 0.79 g/mL.
A) 46 g B) 50 g C) 1.1 g
D) 40. G E) 2.5 g

Mole fraction

70) A sample of rubbing alcohol contains 142.0 g of isopropanol (C_3H_7OH) and 58.0 g of water. The mole fractions of alcohol and water are___.
A. 2.36 and 3.22 B. 0.423 and 0.577 C. 0.236 and 0.322
D. 0.577 and 0.423 E. 0.733 and 1.324

71) Household sugar, sucrose, has the molecular formula $C_{12}H_{22}O_{11}$. What is the % of carbon in sucrose, by mass?

A) 26.7 % B) 33.3 % C) 41.4 % D) 42.1 % E) 52.8 %

72) For many years chloroform ($CHCl_3$) was used as an inhalation anesthetic in spite of the fact that it is also a toxic substance that may cause severe liver, kidney, and heart damage. What is the % of carbon in chloroform, by mass?

A) 10.06 % B) 89.1 % C) 0.84 % D) 12.1 % E) 22.8 %

73) Determine the percent composition of potassium dichromate, $K_2Cr_2O_7$.

A) 17.5 % K, 46.6 % Cr, 35.9 % O
B) 29.8 % K, 39.7 % Cr, 30.5 % O
C) 36.5 % K, 48.6 % Cr, 14.9 % O
D) 37.2 % K, 24.7 % Cr, 38.1 % O
E) 26.58 % K, 35.35 % Cr, 38.07

74) Gadolinium oxide, a colorless powder which absorbs carbon dioxide from the air, contains 86.76 mass % Gd. Determine its empirical formula.

A) Gd_2O_3 B) Gd_3O_2 C) Gd_3O_4 D) Gd_4O_3 E) GdO

75) Hydroxylamine nitrate contains 29.17 mass % N, 4.20 mass % H, and 66.63 mass % O. Determine its empirical formula.

A) HNO B) H_2NO_2 C) HN_6O_{16} D) $HN_{16}O_7$ E) H_2NO_3

76) Hydroxylamine nitrate contains 29.17 mass % N, 4.20 mass % H, and 66.63 mass O. If its molar mass is between 94 and 98 g/mol, what is its molecular formula?

A) NH_2O_5 B) $N_2H_4O_4$ C) $N_3H_3O_3$ D) $N_4H_8O_2$ E) $N_2H_2O_4$

77) Analysis of a carbohydrate showed that it consisted of 40.0 % C, 6.71 % H, and 53.3 % O by mass. Its molecular mass was found to be between 140 and 160 amu. What is the molecular formula of this compound?

A) $C_4H_8O_6$ B) $C_5H_{10}O_5$ C) $C_5H_{12}O_5$
D) $C_6H_{12}O_4$ E) none of the above

78) A compound of bromine and fluorine is used to make UF_6, which is an important chemical in processing and reprocessing of nuclear fuel. The compound contains 58.37 mass percent bromine. Determine its empirical formula.

A) BrF B) BrF_2 C) Br_2F_3 D) Br_3F E) BrF_3

79) A compound containing chromium and silicon contains 73.52 mass percent chromium.
Determine its empirical formula.

A) $CrSi_3$ B) Cr_2Si_3 C) Cr_3Si D) Cr_3Si_2 E) Cr_2S

80) Hydroxylamine hydrochloride is a powerful reducing agent which is used as a polymerization catalyst. It contains 5.80 mass % H, 20.16 mass % N, 23.02 mass % O, and 51.02 mass % Cl. What is its empirical formula?

A) $H_2N_7O_8Cl_{18}$ B) $H_2N_2O_2Cl$ C) $HN_3O_4Cl_9$
D) H_4NOCl E) H_4NOCl_2

81) In the combustion analysis of 0.1127 g of glucose ($C_6H_{12}O_6$), what mass, in grams, of CO_2 would be produced?

A) 0.0451 g B) 0.0825 g C) 0.1652 g
D) 0.4132 g E) 1.466 g

82) Balance the following equation:

$B_2O_3(s)$ + $HF(l)$ → $BF_3(g)$ + $H_2O(l)$

A) $B_2O_3(s) + 6HF(l) \rightarrow 2BF_3(g) + 3H_2O(l)$
B) $B_2O_3(s) + H_6F_6(l) \rightarrow B_2F_6(g) + H_6O_3(l)$
C) $B_2O_3(s) + 2HF(l) \rightarrow 2BF_3(g) + H_2O(l)$
D) $B_2O_3(s) + 3HF(l) \rightarrow 2BF_3(g) + 3H_2O(l)$
E) $B_2O_3(s) + 6HF(l) \rightarrow 2BF_3(g) + 6H_2O(l)$

83) Balance the following equation:

$UO_2(s)$ + $HF(l)$ → $UF_4(s)$ + $H_2O(l)$

A) $UO_2(s) + 2HF(l) \rightarrow UF_4(s) + H_2O(l)$
B) $UO_2(s) + 4HF(l) \rightarrow UF_4(s) + 2H_2O(l)$
C) $UO_2(s) + H_4F_4(l) \rightarrow UF_4(s) + H_4O_2(l)$
D) $UO_2(s) + 4HF(l) \rightarrow UF_4(s) + 4H_2O(l)$
E) $UO_2(s) + 8HF(l) \rightarrow 2UF_4(s) + 4H_2O(l)$

84) Balance the following equation for the combustion of benzene:

$C_6H_6(l)$ + $O_2(g)$ → $H_2O(g)$ + $CO_2(g)$

A) $C_6H_6(l) + 9O_2(g) \rightarrow 3H_2O(g) + 6CO_2(g)$
B) $C_6H_6(l) + 9O_2(g) \rightarrow 6H_2O(g) + 6CO_2(g)$
C) $2C_6H_6(l) + 15O_2(g) \rightarrow 6H_2O(g) + 12CO_2(g)$
D) $C_6H_6(l) + 15O_2(g) \rightarrow 3H_2O(g) + 6CO_2(g)$
E) $2C_6H_6(l) + 9O_2(g) \rightarrow 6H_2O(g) + 12CO_2(g)$

85) Balance the following equation:

$C_8H_{18}O_3(l)$ + $O_2(g)$ → $H_2O(g)$ + $CO_2(g)$

A) $C_8H_{18}O_3(l) + 8O_2(g) \rightarrow 9H_2O(g) + 8CO_2(g)$
B) $C_8H_{18}O_3(l) + 11O_2(g) \rightarrow 9H_2O(g) + 8CO_2(g)$
C) $2C_8H_{18}O_3(l) + 22O_2(g) \rightarrow 9H_2O(g) + 16CO_2(g)$
D) $C_8H_{18}O_3(l) + 13O_2(g) \rightarrow 18H_2O(g) + 8CO_2(g)$
E) $2C_8H_{18}O_3(l) + 17O_2(g) \rightarrow 18H_2O(g) + 16CO_2(g)$

86) How many molecules of molecular oxygen react with four molecules of NH_3 to form four molecules of nitrogen monoxide and six molecules of water?

A) 2 B) 10 C) 3 D) 4 E) 5

87) Sulfur dioxide reacts with chlorine to produce thionyl chloride (used as a drying agent for inorganic halides) and dichlorine oxide (used as a bleach for wood, pulp, and textiles).

$$SO_2(g) + 2Cl_2(g) \rightarrow SOCl_2(g) + Cl_2O(g)$$

If 0.400 mol of Cl_2 reacts with excess SO_2, how many moles of Cl_2O are formed?

A) 0.800 mol B) 0.400 mol C) 0.200 mol
D) 0.100 mol E) 0.0500 mol

88) Aluminum will react with bromine to form aluminum bromide (used as an acid catalyst in organic synthesis).

$$Al(s) + Br_2(l) \rightarrow Al_2Br_6(s) \quad \text{[unbalanced]}$$

How many moles of Al are needed to form 2.43 mol of Al_2Br_6?

A) 7.29 mol B) 4.86 mol C) 2.43 mol
D) 1.62 mol E) 1.22 mol

89) Ammonia will react with fluorine to produce dinitrogen tetrafluoride and hydrogen fluoride (used in production of aluminum, in uranium processing, and in frosting of light bulbs).

$$2NH_3(g) + 5F_2(g) \rightarrow N_2F_4(g) + 6HF(g)$$

How many moles of NH_3 are needed to react completely with 13.6 mol of F_2?

A) 34.0 mol B) 27.2 mol C) 6.80 mol
D) 5.44 mol E) 2.27 mol

90) Ammonia, an important source of fixed nitrogen that can be metabolized by plants, is produced using the Haber process in which nitrogen and hydrogen combine.

$$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$$

How many grams of nitrogen are needed to produce 325 grams of ammonia?

A) 1070 g B) 535 g C) 267 g D) 178 g E) 108 g

91) How many grams of sodium fluoride (used in water fluoridation and manufacture of insecticides) are needed to form 485 g of sulfur tetrafluoride?

$$3SCl_2(l) + 4NaF(s) \rightarrow SF_4(g) + S_2Cl_2(l) + 4NaCl(s)$$

A) 1940 g B) 1510 g C) 754 g D) 205 g E) 51.3 g

92) How many grams of oxygen are needed to react completely with 200.0 g of ammonia, NH_3?

$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$

A) 469.7 g B) 300.6 g C) 250.0 g D) 3.406 g E) 2.180 g

93) Phosphine, an extremely poisonous and highly reactive gas, will react with oxygen to form tetraphosphorus decaoxide and water.

$PH_3(g) + O_2(g) \rightarrow P_4O_{10}(s) + H_2O(g)$ [unbalanced]

Calculate the mass of $P_4O_{10}(s)$ formed when 225 g of PH_3 reacts with excess oxygen.

A) 1880 g B) 940. g C) 900. g

D) 470 g E) 56.3 g

94) Potassium chlorate (used in fireworks, flares, and safety matches) forms oxygen and potassium chloride when heated.

$KClO_3(s) \rightarrow KCl(s) + O_2(g)$ [unbalanced]

How many grams of oxygen are formed when 26.4 g of potassium chlorate is heated?

A) 223 g B) 99.1 g C) 10.3 g
D) 6.86 g E) 4.60 g

95) Aluminum metal reacts with chlorine gas to form solid aluminum trichloride, $AlCl_3$.

What mass of chlorine gas is needed to react completely with 163 g of aluminum?

A) 214 g B) 245 g C) 321 g
D) 489 g E) 643 g

96) Lead(II) sulfide was once used in glazing earthenware. It will also react with hydrogen peroxide to form lead(II) sulfate and water. How many grams of hydrogen peroxide are needed to react completely with 265 g of lead(II) sulfide?

A) 151 g B) 123 g C) 50.3 g D) 37.7 g E) 9.41 g

Limiting reactant

97) Aluminum oxide (used as an adsorbent or a catalyst for organic reactions) forms when aluminum reacts with oxygen.

$4Al(s) + 3O_2(g) \rightarrow 2Al_2O_3(s)$

A mixture of 82.49 g of aluminum ($\mathcal{M}$ = 26.98 g/mol) and 117.65 g of oxygen ($\mathcal{M}$ = 32.00 g/mol) is allowed to react. What mass of aluminum oxide ($\mathcal{M}$ = 101.96 g/mol) can be formed?

A) 155.8 g B) 200.2 g C) 249.9 g D) 311.7 g E) 374.9 g

98) Aluminum reacts with oxygen to produce aluminum oxide which can be used as an adsorbent, desiccant, or catalyst for organic reactions.

$$4Al(s) + 3O_2(g) \rightarrow 2Al_2O_3(s)$$

A mixture of 82.49 g of aluminum ($\mathcal{M}$ = 26.98 g/mol) and 117.65 g of oxygen ($\mathcal{M}$ = 32.00 g/mol) is allowed to react. Identify the limiting reactant and determine the mass of the excess reactant present in the vessel when the reaction is complete.

A) Oxygen is the limiting reactant; 19.81 g of aluminum remain.
B) Oxygen is the limiting reactant; 35.16 g of aluminum remain.
C) Aluminum is the limiting reactant; 16.70 g of oxygen remain.
D) Aluminum is the limiting reactant; 35.16 g of oxygen remain.
E) Aluminum is the limiting reactant; 44.24 g of oxygen remain.

99) Magnesium reacts with iron(III) chloride to form magnesium chloride (which can be used in fireproofing wood and in disinfectants) and iron.

$$3Mg(s) + 2FeCl_3(s) \rightarrow 3MgCl_2(s) + 2Fe(s)$$

A mixture of 41.0 g of magnesium ($\mathcal{M}$ = 24.31 g/mol) and 175 g of iron(III) chloride ($\mathcal{M}$ = 162.2 g/mol) is allowed to react. What mass of magnesium chloride = 95.21 g/mol) is formed?

A) 68.5 g $MgCl_2$
B) 77.0 g $MgCl_2$
C) 71.4 g $MgCl_2$
D) 107 g $MgCl_2$
E) 154 g $MgCl_2$

100) Magnesium (used in the manufacture of light alloys) reacts with iron(III) chloride to form magnesium chloride and iron.

$$3Mg(s) + 2FeCl_3(s) \rightarrow 3MgCl_2(s) + 2Fe(s)$$

A mixture of 41.0 g of magnesium ($\mathcal{M}$ = 24.31 g/mol) and 175 g of iron(III) chloride ($\mathcal{M}$ = 162.2 g/mol) is allowed to react. Identify the limiting reactant and determine the mass of the excess reactant present in the vessel when the reaction is complete.

A) Limiting reactant is Mg; 67 g of $FeCl_3$ remain.
B) Limiting reactant is Mg; 134 g of $FeCl_3$ remain.
C) Limiting reactant is Mg; 104 g of $FeCl_3$ remain.
D) Limiting reactant is $FeCl_3$; 2 g of Mg remain.
E) Limiting reactant is $FeCl_3$; 87 g of Mg remain.

101) Potassium chloride is used as a substitute for sodium chloride for individuals with high blood pressure. Identify the limiting reactant and determine the mass of the excess reactant remaining when 7.00 g of chlorine gas reacts with 5.00 g of potassium to form potassium chloride.

A) Potassium is the limiting reactant; 2.47 g of chlorine remain.
B) Potassium is the limiting reactant; 7.23 g of chlorine remain.
C) Chlorine is the limiting reactant; 4.64 g of potassium remain.
D) Chlorine is the limiting reactant; 2.70 g of potassium remain.
E) No limiting reagent: the reactants are present in the correct stoichiometric ratio.

Percent yield

102) Tetraphosphorus hexaoxide ($\mathcal{M}$ = 219.9 g/mol) is formed by the reaction of phosphorus with oxygen gas.

$$P_4(s) + 3O_2(g) \rightarrow P_4O_6(s)$$

If a mixture of 75.3 g of phosphorus and 38.7 g of oxygen produce 43.3 g of P_4O_6, what is the percent yield for the reaction?

A) 57.5% B) 48.8% C) 38.0% D) 32.4% E) 16.3%

103) What is the percent yield for the reaction

$$PCl_3(g) + Cl_2(g) \rightarrow PCl_5(g)$$

if 119.3 g of PCl_5 (M = 208.2 g/mol) are formed when 61.3 g of Cl_2 ($\mathcal{M}$ = 70.91 g/mol) react with excess PCl_3?

A) 195% B) 85.0% C) 66.3% D) 51.4% E) 43.7%

104) Methanol (CH_4O) is converted to bromomethane (CH_3Br) as follows:

$$CH_4O + HBr \rightarrow CH_3Br + H_2O$$

If 12.23 g of bromomethane are produced when 5.00 g of methanol is reacted with excess HBr, what is the percentage yield?

A) 40.9% B) 82.6% C) 100.% D) 121% E) 245%

105) A 0.150 *M* sodium chloride solution is referred to as a physiological saline solution because it has the same concentration of salts as normal human blood. Calculate the mass of solute needed to prepare 275.0 mL of a physiological saline solution.

A) 41.3 g B) 31.9 g C) 16.1 g D) 8.77 g E) 2.41 g

Making solution and Comprehensive Problems

106) Lithium hydroxide is used in alkaline batteries. Calculate the molarity of a solution prepared by dissolving 1.495 moles of LiOH in enough water to give a final volume of 750. mL.

A) 1.99 *M* B) 1.50 *M* C) 1.12 *M* D) 0.502 *M* E) 0.00199 *M*

107) Hydrochloric acid is widely used as a laboratory reagent in refining ore for the production of tin and tantalum, and as a catalyst in organic reactions. Calculate the number of moles of HCl in 62.85 mL of 0.453 *M* hydrochloric acid.

A) 28.5 mol B) 1.04 mol C) 0.139 mol
D) 0.0285 mol E) 0.00721 mol

108) Calculate the molarity of a 23.55-mL solution which contains 28.24 mg of sodium sulfate (used in dyeing and printing textiles, $\mathcal{M}$ = 139.04 g/mol).

A) 8.625 *M* B) 1.199 *M* C) 0.8339 *M*
D) 0.2031 *M* E) 0.008625 *M*

109) When 2.61 g of solid Na_2CO_3 is dissolved in sufficient water to make 250. mL of solution, the concentration of Na_2CO_3 is:

A) 0.0246 *M* B) 10.4 *M* C) 0.205 *M*
D) 0.0985 *M* E) 0.141 *M*

110) Calcium chloride is used to melt ice and snow on roads and sidewalks and to remove water from organic liquids. Calculate the molarity of a solution prepared by diluting 165 mL of 0.688 *M* calcium chloride to 925.0 mL.

A) 3.86 *M* B) 0.743 *M* C) 0.222 *M*
D) 0.123 *M* E) 0.114 *M*

111) What will be the final volume of a solution prepared by diluting 25 mL of 8.25 *M* sodium hydroxide to a concentration of 2.40 *M?*

A) 330 mL B) 210 mL C) 86 mL D) 60 mL E) 7.3

112) What volume, in L, of 10.0 *M* HCl is needed to make 2.00 L of 2.00 *M* HCl solution by dilution with water?

A) 0.800 L B) 0.400 L C) 0.200 L D) 0.100 L E) none of the above

113) How many mL of concentrated nitric acid (HNO_3, 16.0 *M*) should be diluted with water in order to make 2.00 L of 2.00 *M* solution?

A) 32.0 m B) 62.5 mL C) 125 mL D) 250. mL E) 500. mL

114) How many milliliters of 1.58 *M* HCl are needed to react completely with 23.2 g of $NaHCO_3$ ($\mathcal{M}$ = 84.02 g/mol)?

$HCl(aq) + NaHCO_3(s) \rightarrow NaCl(s) + H_2O(l) + CO_2(g)$

A) 638 mL B) 572 mL C) 536 mL
D) 276 mL E) 175 mL

115) Copper(II) sulfide, CuS, is used in the development of aniline black dye in textile printing. What is the maximum mass of CuS which can be formed when 38.0 mL of 0.500 *M* $CuCl_2$ are mixed with 42.0 mL of 0.600 *M* $(NH_4)_2S$? Aqueous ammonium chloride is the other product.

A) 2.41 g B) 1.82 g C) 1.21 g
D) 0.909 g E) 0.044 g

116) Aqueous potassium iodate (KIO_3) and potassium iodide (KI) react in the presence of dilute hydrochloric acid, as shown below.

$KIO_3(aq) + 5KI(aq) + 6HCl(aq) \rightarrow 3I_2(aq) + 6KCl(aq) + 3H_2O(l)$

What mass of iodine (I_2) is formed when 50.0 mL of 0.020 *M* KIO_3 solution reacts with an excess of KI and HCl?

A) 0.13 g I_2 B) 0.25 g I_2 C) 0.38 g I_2
D) 0.76 g I_2 E) none of the above
