1. Which molecular formula is correctly paired with its corresponding empirical formula?

   A) CO_2 and CO B) C_2H_2 and CH_2
   C) C_6H_6 and C_2H_2 D) P_4O_{10} and P_2O_5

2. What is the empirical formula for C_3H_6?

   A) CH B) CH_2 C) CH_3 D) CH_6

3. What is the empirical formula for the compound $C_6H_{12}O_6$?

   A) CH_2O B) $C_2H_4O_2$
   C) $C_3H_6O_3$ D) $C_6H_{12}O_6$

4. The empirical formula of a compound is CH_2. The molecular formula of this compound could be

   A) CH_4 B) C_2H_2 C) C_2H_4 D) C_2H_6

5. The empirical formula of a compound is CH_2. The molecular formula of this compound could be

   A) CH_4 B) C_2H_2 C) C_2H_4 D) C_3H_3

6. The formula H_2O_2 is an example of

   A) a molecular formula
   B) an empirical formula
   C) an ionic formula
   D) an organic formula

7. What is the gram formula mass of $Na_2CO_3 \cdot 10H_2O$?

   A) 106 g   B) 142 g   C) 266 g   D) 286 g

8. The molar mass of $Ba(OH)_2$ is

   A) 154.3 g   B) 155.3 g
   C) 171.3 g   D) 308.6 g

9. What is the gram-formula mass of $Ca_3(PO_4)_2$?

   A) 248 g/mol   B) 263 g/mol
   C) 279 g/mol   D) 310. g/mol

10. What is the gram formula mass of Li_2SO_4?

    A) 54 g   B) 55 g   C) 110 g   D) 206 g

11. Which substance has the greatest molecular mass?

    A) H_2O_2 B) NO C) CF_4 D) I_2

12. Which represents the greatest mass of chlorine?

    A) 1 mole of chlorine
    B) 1 atom of chlorine
    C) 1 gram of chlorine
    D) 1 molecule of chlorine

13. What is the total number of atoms of oxygen in the formula $Al(ClO_3)_3 \cdot 6H_2O$?

    A) 6   B) 9   C) 10   D) 15

14. How many moles of water are contained in 0.250 mole of $CuSO_4 \cdot 5H_2O$?

    A) 1.25   B) 4.50   C) 40.0   D) 62.5

15. What is the total mass of oxygen in 1.00 mole of $Al_2(CrO_4)_3$?

    A) 192 g   B) 112 g
    C) 64.0 g   D) 48.0 g

16. The total number of moles represented by 20 grams of $CaCO_3$ is

    A) 1   B) 2   C) 0.1   D) 0.2

17. Which sample contains a mole of atoms?

    A) 23 g Na   B) 24 g C
    C) 42 g Kr   D) 78 g K

18. What is the total mass in grams of 0.75 mole of SO_2?

    A) 16 g   B) 24 g   C) 32 g   D) 48 g

19. What is the mass in grams of 1.00 mole of O_2 gas?

    A) 11.2   B) 16.0   C) 22.4   D) 32.0

20. If the empirical formula for an organic compound is CH_2O, then the molecular mass of the compound could be

    A) 135   B) 60   C) 45   D) 15

21. A compound has an empirical formula of CH_2 and a molecular mass of 56. What is its molecular formula?

    A) CH_2 B) C_2H_4 C) C_3H_6 D) C_4H_8

22. Which of the following gases has the greatest density at STP?

    A) SO_2 B) CO_2 C) Cl_2 D) N_2

23. A sample of an unknown gas at STP has a density of 1.25 grams per liter. What is the gram molecular mass of this gas?

    A) 28.0 g   B) 44.0 g
    C) 64.0 g   D) 80.0 g

24. A compound consists of 25.9% nitrogen and 74.1% oxygen by mass. What is the empirical formula of the compound?

    A) NO B) NO_2 C) N_2O D) N_2O_5

25. What is the empirical formula of a compound that contains 30.4% nitrogen and 69.6% oxygen by mass?

    A) NO B) NO_2 C) N_2O_3 D) N_2O_5

26. A compound consists of 40.% sulfur and 60.% oxygen by mass. What is the empirical formula of this compound?

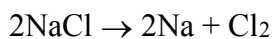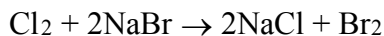   A) SO B) SO_2 C) SO_3 D) SO_4

27. What is the percent by mass of carbon in CO_2?

    A) 12   B) 27   C) 44   D) 73

28. What is the percent composition by mass of nitrogen in NH_4NO_3 (gram-formula mass = 80.0 grams/mole)?

    A) 17.5%   B) 35.0%

    C) 52.5%   D) 60.0%

29. Given the balanced equations representing two chemical reactions:

    $$Cl_2 + 2NaBr \rightarrow 2NaCl + Br_2$$
    $$2NaCl \rightarrow 2Na + Cl_2$$

    Which type of chemical reactions are represented by these equations?

    A) single replacement and decomposition
    B) single replacement and double replacement
    C) synthesis and decomposition
    D) synthesis and double replacement

30. Which balanced equation represents a chemical change?

    A) $H_2O(\ell) + energy \rightarrow H_2O(g)$
    B) $2H_2O(\ell) + energy \rightarrow 2H_2(g) + O_2(g)$
    C) $H_2O(\ell) \rightarrow H_2O(s) + energy$
    D) $H_2O(g) \rightarrow H_2O(\ell) + energy$

31. $2\,CO(g) + O_2(g) \leftrightarrow 2\,CO_2(g)$

    What type of reaction is shown above?

    A) synthesis   B) decomposition
    C) single replacement   D) double replacement

32. $Ba(NO_3)_2(aq) + Na_2SO_4(aq) \rightarrow$
                    $2\,NaNO_3(aq) + BaSO_4(s)$

    What type of reaction is shown above?

    A) synthesis   B) decomposition
    C) single replacement   D) double replacement

33. Given the reaction at 101.3 kilopascals and 298 K:

    hydrogen gas + iodine gas $\rightarrow$ hydrogen iodide gas
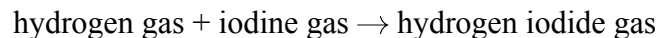
    This reaction is classified as

    A) endothermic, because heat is absorbed
    B) endothermic, because heat is released
    C) exothermic, because heat is absorbed
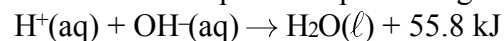   D) exothermic, because heat is released

34. Which equation shows a conservation of mass?

    A) $Na + Cl_2 \rightarrow NaCl$ B) $Al + Br_2 \rightarrow AlBr_3$
    C) $H_2O \rightarrow H_2 + O_2$ D) $PCl_5 \rightarrow PCl_3 + Cl_2$

35. Which equation shows conservation of atoms?

    A) $H_2 + O_2 \rightarrow H_2O$
    B) $H_2 + O_2 \rightarrow 2H_2O$
    C) $2H_2 + O_2 \rightarrow 2H_2O$
    D) $2H_2 + 2O_2 \rightarrow 2H_2O$

36. Given the balanced equation representing a reaction:
    $$H^+(aq) + OH^-(aq) \rightarrow H_2O(\ell) + 55.8 \text{ kJ}$$
    In this reaction there is conservation of

    A) mass, only
    B) mass and charge, only
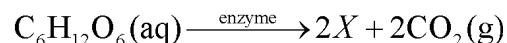   C) mass and energy, only
    D) mass, charge, and energy

37. Base your answer to the following question on Given the unbalanced equation:

    $$\_\_Al + \_\_CuSO_4 \rightarrow \_\_Al_2(SO_4)_3 + \_\_Cu$$
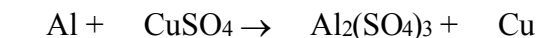
    When the equation is balanced using the *smallest* whole-number coefficients, what is the coefficient of Al?

    A) 1   B) 2   C) 3   D) 4

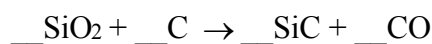38. Given the balanced equation with an unknown compound represented by X:
    $$C_6H_{12}O_6(aq) \xrightarrow{\text{enzyme}} 2X + 2CO_2(g)$$
    Which compound is represented by X?

    A) $CH_3OH(aq)$ B) $CH_2(OH)_4(aq)$
    C) $CH_3CH_2OH(aq)$ D) $CH_2OHCH_2OH(aq)$

39. When the equation

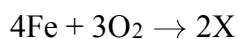$$\_\_SiO_2 + \_\_C \rightarrow \_\_SiC + \_\_CO$$

is correctly balanced using whole-number coefficients, the sum of all the coefficients is

A) 6   B) 7   C) 8   D) 9

40. Which chemical equation is correctly balanced?

A) $H_2(g) + O_2(g) \rightarrow H_2O(g)$
B) $N_2(g) + H_2(g) \rightarrow NH_3(g)$
C) $2NaCl(s) \rightarrow Na(s) + Cl_2(g)$
D) $2KCl(s) \rightarrow 2K(s) + Cl_2(g)$

41. Given the incomplete equation:

$$4Fe + 3O_2 \rightarrow 2X$$

Which compound is represented by X?

A) FeO B) Fe_2O_3
C) Fe_3O_2 D) Fe_3O_4

42. Given the balanced equation representing a reaction:

$$4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$$
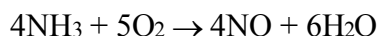
What is the *minimum* number of moles of O_2 that are needed to completely react with 16 moles of NH_3?

A) 16 mol   B) 20. mol
C) 64 mol   D) 80. mol

43. Given the balanced equation representing the reaction between propane and oxygen:

$$C_3H_8 + 5\,O_2 \rightarrow 3\,CO_2 + 4\,H_2O$$
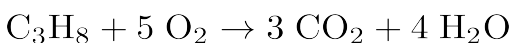
According to this equation, which ratio of oxygen to propane is correct?

A) $\dfrac{5 \text{ grams } O_2}{1 \text{ gram } C_3H_8}$ B) $\dfrac{5 \text{ moles } O_2}{1 \text{ mole } C_3H_8}$

C) $\dfrac{10 \text{ grams } O_2}{11 \text{ grams } C_3H_8}$ D) $\dfrac{10 \text{ moles } O_2}{11 \text{ moles } C_3H_8}$
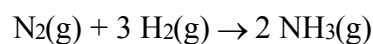
44. Base your answer to the following question on Given the balanced equation:

$$2C + 3H_2 \rightarrow C_2H_6$$
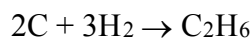
What is the total number of moles of C that must completely react to produce 2.0 moles of C_2H_6?

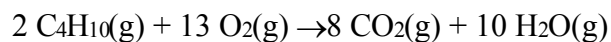A) 1.0 mol   B) 2.0 mol
C) 3.0 mol   D) 4.0 mol

45. Given the reaction:

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

What is the total number of moles of $NH_3(g)$ produced when 10. moles of $H_2(g)$ reacts completely with $N_2(g)$?
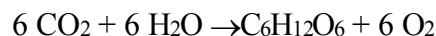
A) 6.7   B) 2.0   C) 3.0   D) 15

46. Base your answer to the following question on Given the balanced equation:

$$2\,C_4H_{10}(g) + 13\,O_2(g) \rightarrow 8\,CO_2(g) + 10\,H_2O(g)$$

What is the total number of moles of $O_2(g)$ that must react completely with 5.00 moles of $C_4H_{10}(g)$?
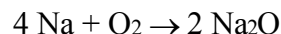
A) 10.0   B) 20.0   C) 26.5   D) 32.5

47. Base your answer to the following question on Given the reaction:

$$6\,CO_2 + 6\,H_2O \rightarrow C_6H_{12}O_6 + 6\,O_2$$

What is the total number of moles of water needed to make 2.5 moles of $C_6H_{12}O_6$?

A) 2.5   B) 6.0   C) 12   D) 15

48. Given the reaction:

$$4\,Na + O_2 \rightarrow 2\,Na_2O$$
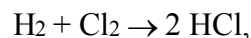
How many grams of oxygen are completely consumed in the production of 1.00 mole of Na_2O?

A) 16.0   B) 32.0   C) 62.0   D) 124

49. According to the reaction

$$H_2 + Cl_2 \rightarrow 2\,HCl,$$

the production of 2.0 moles of HCl would require 70. grams of Cl_2 and

A) 1.0 g of H_2 B) 2.0 g of H_2
C) 3.0 g of H_2 D) 4.0 g of H_2

50. Given the reaction:

$$Cu + 4\,HNO_3 \rightarrow Cu(NO_3)_2 + 2\,H_2O + 2\,NO_2$$
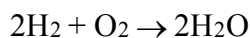
What is the total mass of H_2O produced when 32 grams of Cu is completely consumed?

A) 9.0 g   B) 18 g   C) 36 g   D) 72 g

51. Base your answer to the following question on Given
    the balanced equation representing a reaction:

    $2H_2 + O_2 \rightarrow 2H_2O$

    What is the total mass of water formed when 8 grams of
    hydrogen reacts completely with 64 grams of oxygen?

    A) 18 g   B) 36 g   C) 56 g   D) 72 g

52. What is the approximate total number of atoms in 1.0
    mole of lithium?

    A) 1.0×10^{23} B) 6.0×10^{23}
    C) 3.0   D) 6.9

53. How many molecules are in 0.25 mole of O_2?

    A) 12×10^{23} B) 6.0×10^{23}
    C) 3.0×10^{23} D) 1.5×10^{23}

54. What is the total volume occupied by 132 grams of CO_2
    (g) at STP?
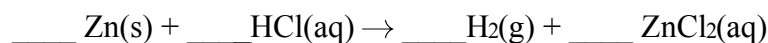
    A) 22.4 L   B) 33.6 L
    C) 44.8 L   D) 67.2 L

55. At STP, 1 mole of He(g) contains the same number of
    atoms as

    A) 22.4 L of H_2(g)   B) 44.8 L of H_2(g)
    C) 22.4 L of Ar(g)   D) 44.8 L of Ar(g)

56. Base your answer to the following question on the information below.

    A 1.0-gram strip of zinc is reacted with hydrochloric acid in a test tube. The unbalanced equation below
    represents the reaction.

    _____ Zn(s) + _____HCl(aq) → _____H_2(g) + _____ ZnCl_2(aq)

    Balance the equation for the reaction of zinc and hydrochloric acid, using the smallest whole-number
    coefficients.

    Base your answers to questions **57** and **58** on the information below.

    Vitamin C, also known as ascorbic acid, is water soluble and cannot be produced by the
    human body. Each day, a person's diet should include a source of vitamin C, such as orange
    juice. Ascorbic acid has a molecular formula of $C_6H_8O_6$ and a gram-formula mass of 176
    grams per mole.

57. Show a numerical setup for calculating the percent composition by mass of oxygen in ascorbic acid.

58. Write the empirical formula for ascorbic acid.

Base your answers to questions **59** and **60** on the information below.

A tablet of one antacid contains citric acid, $H_3C_6H_5O_7$, and sodium hydrogen carbonate, $NaHCO_3$. When the tablet dissolves in water, bubbles of CO_2 are produced. This reaction is represented by the incomplete equation below.

$H_3C_6H_5O_7(aq) + 3NaHCO_3(aq) \rightarrow Na_3C_6H_5O_7(aq) + 3CO_2(g) + 3$ _____ (ℓ)

59. Determine the total number of moles of sodium hydrogen carbonate that will completely react with 0.010 mole of citric acid.

60. write the formula of the missing product.

_____

61. Base your answer to the following question on the information below.

In an experiment, 2.54 grams of copper completely reacts with sulfur, producing 3.18 grams of copper(I) sulfide.

Write the chemical formula of the compound produced.

_____

Base your answers to questions **62** through **64** on the information below.

Hydrogen peroxide, H_2O_2, is a water-soluble compound. The concentration of an aqueous hydrogen peroxide solution that is 3% by mass H_2O_2 is used as an antiseptic. When the solution is poured on a small cut in the skin, H_2O_2 reacts according to the balanced equation below.

$$2H_2O_2 \rightarrow 2H_2O + O_2$$
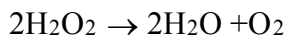
62. Determine the gram-formula mass of H_2O_2.

63. Calculate the total mass of H_2O_2 in 20.0 grams of an aqueous H_2O_2 solution that is used as an antiseptic. Your response must include *both* a numerical setup and the calculated result.

64. Identify the type of chemical reaction represented by the balanced equation.

_____

65. Given the unbalanced equation:

__$Al(OH)_3$ + __H_2SO_4 → __$Al_2(SO_4)_3$ + __H_2O
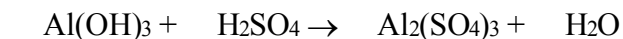
Balance the equation using smallest whole number coefficients.

66. Given the unbalanced equation:

__C_2H_6 + __O_2 → __CO_2 + __H_2O
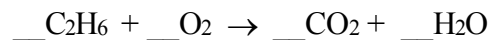
Balance the equation using smallest whole number coefficients.

67. In a laboratory experiment, a student determined the mass of the product, LiCl(s), to be 0.333 grams.

    a   Calculate the gram formula mass of LiCl(s). Round atomic masses from the Periodic Table to the nearest tenth. [Show all work. Indicate the correct answer in proper significant figures and include an appropriate unit.]

    b   Calculate the number of moles of LiCl(s) produced. [Show all work. Indicate the correct answer in proper significant figures.]

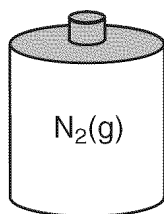68. Base your answer to the following question on the information and diagrams below.

    Cylinder A contains 22.0 grams of $CO_2(g)$ and cylinder B contains $N_2(g)$. The volumes, pressures, and temperatures of the two gases are indicated under each cylinder.

    Cylinder A   **Cylinder B**

    $CO_2(g)$ $N_2(g)$
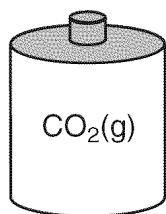
    V = 12.3 L   V = 12.3 L
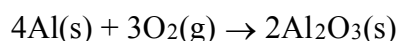   P = 1.0 atm   P = 1.0 atm
    T = 300. K   T = 300. K

    Explain why the number of molecules of $N_2(g)$ in cylinder B is the same as the number of molecules of $CO_2(g)$ in cylinder A.

69. Given the balanced equation:

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

    What is the total number of moles of $O_2(g)$ that must react completely with 8.0 moles of Al(s) in order to form $Al_2O_3(s)$?

70. Base your answer to the following question on the information below.

    A scientist in a chemistry laboratory determined the molecular formulas for two compounds containing nitrogen and oxygen to be NO_2 and N_2O_5

    Write an IUPAC name for the compound N_2O_5.