1. To determine the formula mass of a compound you should
   A) add up the atomic masses of all the atoms present.
   B) add up the atomic masses of all the atoms present and divide by the number of atoms present.
   C) add up the atomic numbers of all the atoms present.
   D) add up the atomic numbers of all the atoms present and divide by the number of atoms present.

2. Which of the following compounds has the largest formula mass?
   A) H₂O
   B) NH₃
   C) CO
   D) BeH₂

3. The formula mass of ammonium sulfite, (NH₄)₂SO₃, is
   A) 98.1 amu
   B) 112.1 amu
   C) 116.14 amu
   D) 136.16 amu

4. A compound with the formula TeFₙ has a formula mass of 203.59 amu. What is the value for n in the formula TeFₙ?
   A) 2
   B) 3
   C) 4
   D) 6

5. A mole of a chemical substance represents
   A) the mass of the substance that will combine with 12.0 g of carbon.
   B) the mass of the substance that will combine with 100.0 g of oxygen.
   C) \(6.02 \times 10^{23}\) chemical particles of the substance.
   D) \(6.02 \times 10^{-23}\) grams of the substance.

6. Which of the following statements concerning Avogadro's number is correct?
   A) It has the value \(6.02 \times 10^{-23}\).
   B) It denotes the number of molecules in one mole of any molecular substance.
   C) It is the mass, in grams, of one mole of any substance.
   D) It denotes the number of atoms in one mole of any substance.
7. In which of the following molar quantities of sulfur would $7.16 \times 10^{23}$ atoms of sulfur be present?
   A) 0.99 moles S  
   B) 1.09 moles S  
   C) 1.19 moles S  
   D) 1.29 moles S

8. Avogadro's number of gallium (Ga) would have a mass of
   A) $6.02 \times 10^{-23}$ g  
   B) $6.02 \times 10^{23}$ g  
   C) 35  
   D) 70

9. Which of the following samples has the largest mass, in grams?
   A) 16 moles of CSe$_2$  
   B) 17 moles of CN  
   C) 18 moles of H$_2$O  
   D) 19 moles of H$_2$

10. Which of the following samples contains the greatest number of atoms?
    A) 6 mole of CS$_2$  
    B) 7 moles of He  
    C) 8 moles of N$_2$O  
    D) 9 moles of CO

11. Which of the following is the correct "set-up" for the problem "How many atoms are present in 26.0 g Te?"
    A) $26.0 \text{ g Te} \times \left( \frac{6.02 \times 10^{23} \text{ atoms Te}}{1.0 \text{ g Te}} \right)$
    B) $26.0 \text{ g Te} \times \left( \frac{1 \text{ mole Te}}{127.60 \text{ g Te}} \frac{1 \text{ atom Te}}{6.02 \times 10^{23} \text{ moles Te}} \right)$
    C) $26.0 \text{ g Te} \times \left( \frac{1 \text{ mole Te}}{127.60 \text{ g Te}} \frac{6.02 \times 10^{23} \text{ moles Te}}{1 \text{ atom Te}} \right)$
    D) $26.0 \text{ g Te} \times \left( \frac{6.02 \times 10^{23} \text{ atoms Te}}{6.02 \times 10^{23} \text{ g Te}} \right)$
12. The "set-up" for the problem, "What is the mass, in grams, of $2.10 \times 10^2$ atoms of Al?" which follows is correct, except numbers in the middle conversion factor have been replaced by the letters A and B. What are the numerical values of A and B, respectively?

$$2.10 \times 10^2 \text{ atoms Al} \times \left( \frac{A \text{ moles Al}}{B \text{ atoms Al}} \right) \times \left( \frac{26.98 \text{ g Al}}{1 \text{ mole Al}} \right)$$

A) 1 and $6.02 \times 10^{23}$
B) 1 and 26.98
C) $6.02 \times 10^{23}$ and 1
D) 26.98 and $6.02 \times 10^{23}$

13. Which of the following is the correct "set-up" for the problem "How many grams of S are present in 46.0 g of S$_4$N$_4$?

A) $46.0 \text{ g S}_4\text{N}_4 \times \left( \frac{1 \text{ mole S}_4\text{N}_4}{184.32 \text{ g S}_4\text{N}_4} \right) \times \left( \frac{4 \text{ moles S}}{1 \text{ mole S}_4\text{N}_4} \right) \times \left( \frac{32.07 \text{ g S}}{4 \text{ moles S}} \right)$

B) $46.0 \text{ g S}_4\text{N}_4 \times \left( \frac{1 \text{ mole S}_4\text{N}_4}{184.32 \text{ g S}_4\text{N}_4} \right) \times \left( \frac{4 \text{ moles S}}{1 \text{ mole S}_4\text{N}_4} \right) \times \left( \frac{32.07 \text{ g S}}{1 \text{ mole S}} \right)$

C) $46.0 \text{ g S}_4\text{N}_4 \times \left( \frac{1 \text{ mole S}_4\text{N}_4}{184.32 \text{ g S}_4\text{N}_4} \right) \times \left( \frac{1 \text{ moles S}}{1 \text{ mole S}_4\text{N}_4} \right) \times \left( \frac{32.07 \text{ g S}}{1 \text{ mole S}} \right)$

D) $46.0 \text{ g S}_4\text{N}_4 \times \left( \frac{1 \text{ mole S}_4\text{N}_4}{184.32 \text{ g S}_4\text{N}_4} \right) \times \left( \frac{1 \text{ mole S}}{4 \text{ moles S}_4\text{N}_4} \right) \times \left( \frac{32.07 \text{ g S}}{1 \text{ mole S}} \right)$

14. How many molecules of CO$_2$ are present in 97.3 of CO$_2$?

A) $1.33 \times 10^{25}$
B) $1.33 \times 10^{24}$
C) $1.34 \times 10^{23}$
D) $1.32 \times 10^{25}$

15. Which of the following chemical equations is balanced?

A) $2\text{H}_2 + \text{O}_2 \rightarrow \text{H}_2\text{O}$
B) $2\text{SO}_2 + 2 \text{O}_2 \rightarrow 3 \text{SO}_3$
C) $\text{KClO}_3 \rightarrow \text{KCl} + 3 \text{O}_2$
D) $\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3$
16. Which set of coefficients balances the equation \( \text{C}_4\text{H}_{10} + \_\text{O}_2 \rightarrow \_\text{CO}_2 + \_\text{H}_2\text{O} \)
A) 1, 6, 4, 5  
B) 1, 7, 4, 5  
C) 1, 3, 4, 5  
D) 2, 13, 8, 10

17. Potassium forms an oxide with the formula K\(_2\)O. What is the coefficient of oxygen in the balanced equation for the reaction of potassium with oxygen to form this oxide?
A) 1  
B) 2  
C) 3  
D) 4

18. Which one of the following conversion factors is not consistent with the equation
\[ 4\text{NH}_3 + 5\text{O}_2 \rightarrow 4\text{NO} + 6\text{H}_2\text{O} \]
A) \( \frac{5 \text{ moles } \text{O}_2}{6 \text{ moles } \text{H}_2\text{O}} \)  
B) \( \frac{4 \text{ moles } \text{NO}}{4 \text{ moles } \text{NH}_3} \)  
C) \( \frac{4 \text{ moles } \text{NH}_3}{5 \text{ moles } \text{H}_2\text{O}} \)  
D) \( \frac{4 \text{ moles } \text{NO}}{5 \text{ moles } \text{O}_2} \)
19. Which of the following is the correct "set-up" for the problem "How many grams of H₂O will be produced from 1.2 moles of O₂ and an excess of H₂S" according to the reaction 2H₂S + 3O₂ → 2H₂O + 2SO₂

A) 1.2 moles O₂ × \( \frac{18.02 \text{ g H}_2\text{O}}{2 \text{ moles H}_2\text{O}} \)

B) 1.2 moles O₂ × \( \frac{32.00 \text{ g O}_2}{1 \text{ mole O}_2} \) × \( \frac{18.02 \text{ g H}_2\text{O}}{32.00 \text{ g O}_2} \)

C) 1.2 moles O₂ × \( \frac{2 \text{ moles H}_2\text{O}}{3 \text{ mole O}_2} \) × \( \frac{18.02 \text{ g H}_2\text{O}}{1 \text{ mole H}_2\text{O}} \)

D) 1.2 moles O₂ × \( \frac{32.00 \text{ g O}_2}{1 \text{ mole O}_2} \) × \( \frac{2 \text{ moles H}_2\text{O}}{3 \text{ moles O}_2} \)

20. In the following reaction, how many grams of H₂O are produced if 6.64 g of N₂H₄ react?

A) 1.87 g
B) 3.73 g
C) 6.64 g
D) 7.46 g

21. Which of the following substances has a formula mass that is greater than 80.0 amu?

A) Cl₂O
B) OF₂
C) SO₂
D) more than one correct response
E) no correct response

22. In which of the following groups of substances do all members of the group have atomic masses that are within 1.00 amu of each other?

A) CH₄, NH₃, H₂O
B) CO, N₂, NO
C) C₃H₈, CO₂, N₂O
D) more than one correct response
E) no correct response

23. A mole of a chemical substance represents

A) the formula mass of that substance expressed in atomic mass units.
B) Avogadro's number of grams of that substance.
C) the mass of that substance that will combine with 1.00 gram of carbon.
D) more than one correct response
E) no correct response
24. The atomic masses of He and Be are 4.00 and 9.01 amu, respectively. Which of the following statements are true?
A) A mole of Be contains more atoms than a mole of He.
B) A mole of He is heavier than a mole of Be.
C) A mole of Be contains the same number of atoms as a mole of He.
D) more than one correct response
E) no correct response

25. One mole of H₂SO₄ contains
A) 2 moles H atoms.
B) 4 moles S atoms.
C) 7 moles of atoms.
D) more than one correct response
E) no correct response

26. Avogadro’s number is equal to the number of
A) atoms in 1 mole of N₂
B) molecules in 1 mole of N₂O₄
C) atoms in ½ mole of CO
D) more than one correct response
E) no correct response

27. In which of the following pairings of masses does the first listed mass contain more moles of substance than the second listed mass?
A) 18.02 g H₂O and 18.02 g NH₃
B) 44.01 g CO₂ and 44.01 g CO
C) 105 g CH₄ and 105 g NO₂
D) more than one correct response
E) no correct response

28. Which of the following samples has a mass greater than 50.00 grams?
A) 6.02 × 10²³ atoms of Fe
B) 3.01 × 10²³ molecules of CH₄
C) 9.03 × 10²³ molecules of H₂O
D) more than one correct response
E) no correct response
29. For which of the following compounds does 1.9 g represent $4.3 \times 10^{-2}$ moles of compound?
   A) CO$_2$
   B) C$_3$H$_8$
   C) H$_2$O$_2$
   D) more than one correct response
   E) no correct response

30. Which of the following statements is true for all balanced equations?
   A) The total number of molecules on each side must be equal.
   B) The sum of the subscripts on each side must be equal.
   C) The sum of the coefficients on each side must be equal.
   D) more than one correct response
   E) no correct response

31. The balanced equation $2\text{CO} + \text{O}_2 \rightarrow 2\text{CO}_2$ tells us that
   A) one gram of O$_2$ will produce two grams of CO$_2$.
   B) two molecules of CO will react with one molecule of O$_2$.
   C) one mole of CO will produce two moles of CO$_2$.
   D) more than one correct response
   E) no correct response

32. Which of the following equations is balanced?
   A) FeS + 2HBr $\rightarrow$ FeBr$_2$ + 2H$_2$S
   B) PbO$_2$ + 2H$_2$ $\rightarrow$ Pb + 2H$_2$O
   C) Fe$_2$O$_3$ + 3H$_2$ $\rightarrow$ 2Fe + 3H$_2$O
   D) more than one correct response
   E) no correct response

33. The balanced equation C + O$_2$ $\rightarrow$ CO$_2$ tells us that 24.02 g of C will exactly react with
   A) 32.00 g of O$_2$.
   B) 2.000 moles of O$_2$.
   C) $6.02 \times 10^{23}$ molecules of O$_2$.
   D) more than one correct response
   E) no correct response
34. Which of the following elemental gases is not represented as a diatomic molecule in a chemical equation?
   A) hydrogen
   B) fluorine
   C) nitrogen
   D) more than one correct response
   E) no correct response

35. In which of the following unbalanced equations are 5 moles of reactants required to produce 2 moles of products?
   A) Na + N₂ → NaN₃
   B) Al + S → Al₂S₃
   C) N₂ + H₂ → NH₃
   D) more than one correct response
   E) no correct response

Use the following to answer questions 36-45:

In each of the following multiple-choice questions, characterize EACH of the three given statements as being TRUE or FALSE and then indicate the collective true-false status of the statements using the choices
   a) All three statements are true.
   b) Two of the three statements are true.
   c) Only one of the statements is true.
   d) None of the statements is true.

36. Statements:
   (1) The molar mass of an element, in the solid state, has the same numerical value as the element's atomic mass.
   (2) In a balanced chemical equation, the number of reactants must equal the number of products.
   (3) One mole of N₂O₄ contains six moles of atoms.
   A) All three statements are true.
   B) Two of the three statements are true.
   C) Only one of the statements is true.
   D) None of the statements is true.
37. Statements:
   (1) Atoms are neither created nor destroyed in an ordinary chemical reaction.
   (2) The mass of a mole of a substance depends on the identity of the substance.
   (3) One mole of O$_2$ molecules contains $6.02 \times 10^{23}$ molecules.
   A) All three statements are true.
   B) Two of the three statements are true.
   C) Only one of the statements is true.
   D) None of the statements is true.

38. Statements:
   (1) In the notation $2\text{H}_2\text{O}$, the 2 out in front is called a coefficient.
   (2) Atomic masses and formula masses are specified using the same units.
   (3) In a formula-based “grams of A to grams of B” problem, molar masses are needed in each of the first two conversion factors.
   A) All three statements are true.
   B) Two of the three statements are true.
   C) Only one of the statements is true.
   D) None of the statements is true.

39. Statements:
   (1) 2.0 moles of NO contains the same number of oxygen atoms as 1.0 mole of CO$_2$.
   (2) The coefficients in a balanced equation give the fixed molar ratios between reactants and products.
   (3) Avogadro's numbers is an experimentally determined quantity.
   A) All three statements are true.
   B) Two of the three statements are true.
   C) Only one of the statements is true.
   D) None of the statements is true.

40. Statements:
   (1) 3.0 moles of CO has a greater mass, in grams, than does 2.0 moles of CO$_2$.
   (2) In a balanced chemical equation, there must be the same total number of molecules on each side of the equation.
   (3) The molar mass and formula mass for a compound have different units but the same numerical value.
   A) All three statements are true.
   B) Two of the three statements are true.
   C) Only one of the statements is true.
   D) None of the statements is true.
41. Statements:
   (1) Two moles of $O_2$ molecules contain twice Avogadro's number of atoms.
   (2) The formula mass for $CO_2$ is 42.0 g.
   (3) In an equation-based “grams of A to grams of B” problem, equation coefficients become part of the first needed conversion factor.
   A) All three statements are true.
   B) Two of the three statements are true.
   C) Only one of the statements is true.
   D) None of the statements is true.

42. Statements:
   (1) Six mole-to-mole relationships are obtainable from a balanced chemical equation involving two reactants and two products.
   (2) The compound $H_2O$ has a greater formula mass than does the compound $NH_3$.
   (3) The atomic mass unit (amu) and the gram unit (g) area related to one another through Avogadro's number.
   A) All three statements are true.
   B) Two of the three statements are true.
   C) Only one of the statements is true.
   D) None of the statements is true.

43. Statements:
   (1) Avogadro's number is part of the conversion factor needed to solve a “moles of A to grams of A” problem.
   (2) The sum of the coefficients in the balanced equation for the production of water from hydrogen gas and oxygen gas is 5.
   (3) 2.00 moles of $NH_3$ molecules has a mass of 34.0 grams.
   A) All three statements are true.
   B) Two of the three statements are true.
   C) Only one of the statements is true.
   D) None of the statements is true.

44. Statements:
   (1) In balancing an equation, formula subscripts are adjusted as needed to obtain the balance.
   (2) 1.00 mole of C contains the same number of atoms as does 12.0 g of C.
   (3) Both a microscopic and macroscopic level of interpretation exist for a chemical formula with the former involving atoms and the latter involving molecules.
   A) All three statements are true.
   B) Two of the three statements are true.
   C) Only one of the statements is true.
   D) None of the statements is true.
45. Statements:
   (1) The major use for sulfuric acid is car batteries.
   (2) Sulfuric acid is the number two chemical in the United States in terms of production amount.
   (3) The raw materials needed for industrial sulfuric acid production are sulfur, air and water.
   A) All three statements are true.
   B) Two of the three statements are true.
   C) Only one of the statements is true.
   D) None of the statements is true.

Use the following to answer questions 46-50:

For each of the quantities, select the correct numerical value from the response. Responses on the right may be used more than once or need not be used at all.

a) 12.0
b) 24.0
c) 44.0
d) 88.0

46. Atomic mass, in amu, of C

47. Formula mass, in amu, of CO₂

48. Molar mass, in grams, of CO₂

49. Mass, in grams, of $6.02 \times 10^{23}$ atoms of C

50. Mass, in grams, of 2.00 moles of CO₂

Use the following to answer questions 51-55:

For each of the problems, select the correct numerical value from the response. Responses on the right may be used more than once or need not be used at all.

a) 1
b) 2
c) 6
d) 12
51. Number of moles of S in 2 moles of H\(_2\)SO\(_4\)

52. Number of moles of atoms in 2 moles of SO\(_2\)

53. Number of moles of O\(_2\) molecules in 2 moles of O\(_2\)

54. Number of moles of O atoms in 3 moles of O\(_2\)

55. Number of moles of H in 1 mole of (NH\(_4\))\(_3\)PO\(_4\)

Use the following to answer questions 56-60:

Contrast the magnitudes, to three significant figures, of the paired quantities and then select an appropriate response from the response. Responses on the right may be used more than once or need not be used at all.

a) I is greater than II
b) I is equal to II
c) I is less than II
d) I and II cannot be compared because of insufficient information

56. (I) Mass of 1 mole of CO\(_2\), (II) Mass of 1 mole of NH\(_3\)

57. (I) Moles in 28.0 g of N\(_2\), (II) Moles in 28.0 g of CO

58. (I) Molecules in 2 moles of CO, (II) Molecules in 2 moles of CO\(_2\)

59. (I) Atoms in 3 moles of CO, (II) Atoms in 2 moles of CO\(_2\)

60. (I) Molecules in 28.0 g of N\(_2\), (II) Molecules in 28.0 g of O\(_2\)
Use the following to answer questions 61-65:

For each of the equations, select the set of coefficients from the response that correctly balances the equation. Responses on the right may be used more than once or need not be used at all.

a) 1, 1, 2
b) 1, 2, 1
c) 2, 1, 2
d) 3, 1, 2

61. $\text{CH}_4 \rightarrow \_\_\_\_\_\text{C}_3\text{H}_8 + \_\_\text{H}_2$

62. $\text{N}_2 + \_\_\text{O}_2 \rightarrow \_\_\text{NO}$

63. $\text{SO}_2 + \_\_\text{O}_2 \rightarrow \_\_\text{SO}_3$

64. $\text{H}_2 + \_\_\text{N}_2 \rightarrow \_\_\text{NH}_3$

65. $\text{CO} + \_\_\text{O}_2 \rightarrow \_\_\text{CO}_2$

Use the following to answer questions 66-70:

Each of the numerical problems relate to the following equation:

$$2\text{C}_2\text{H}_6 + 7\text{O}_2 \rightarrow 4\text{CO}_2 + 6\text{H}_2\text{O}$$

For each problem select the correct numerical value from the response. Responses on the right may be used more than once or need not be used at all.

a) 6
b) 7
c) 8
d) 14

66. Molecules of O$_2$ that react with 2 molecules of C$_2$H$_6$

67. Moles of O$_2$ that react with 4 moles of C$_2$H$_6$

68. Molecules of CO$_2$ produced when 4 molecules of C$_2$H$_6$ react

69. Moles of O$_2$ needed to produce 12 moles of H$_2$O
70. Moles of CO₂ produced at the same time 9 moles of H₂O are produced
Answer Key

1. A
2. C
3. C
4. C
5. C
6. B
7. C
8. D
9. A
10. C
11. C
12. A
13. B
14. B
15. D
16. D
17. A
18. C
19. C
20. D
21. A
22. C
23. E
24. C
25. D
26. D
27. C
28. A
29. D
30. E
31. B
32. D
33. B
34. E
35. A
36. B
37. A
38. B
39. A
40. C
41. D
42. A
43. B
44. C
45. C
46. a
47. c
48. c
49. a
50. d
51. b
52. c
53. b
54. c
55. d
56. a
57. b
58. b
59. b
60. A
61. d
62. a
63. c
64. d
65. c
66. b
67. d
68. c
69. d
70. A