Multiple Choice
Identify the letter of the choice that best completes the statement or answers the question.
Each correct answer is worth 0.5 points.

1. The active ingredient in household bleach is sodium hypochlorite, $\text{NaClO}_2$. What is the formula weight of sodium hypochlorite?
   a. 74.5 amu
   b. 90.5 amu
   c. 110 amu
   d. 149 amu

2. Formic acid, $\text{HCOOH}$, is what causes the sting of bee stings. What is the formula weight of formic acid?
   a. 29 amu
   b. 46 amu
   c. 50 amu
   d. 58 amu

3. Hospital ether, diethyl ether, has the formula $(\text{C}_2\text{H}_5)_2\text{O}$. What is the formula weight of diethyl ether?
   a. 28 amu
   b. 45 amu
   c. 74 amu
   d. 90 amu

4. When comparing one mole of water with one mole of carbon dioxide which of the following is true?
   a. they contain the same number of atoms
   b. they contain the same number of molecules
   c. both (a) and (b) are true
   d. both (a) and (b) are false

5. When comparing one mole of water with one mole of ammonia which of the following is true?
   a. they contain the same number of atoms
   b. they contain the same number of molecules
   c. both (a) and (b) are true
   d. both (a) and (b) are false

6. How many atoms are in a mole of sodium chloride compound, $\text{NaCl}$?
   a. 1
   b. 2
   c. $6.02 \times 10^{23}$
   d. $1.20 \times 10^{24}$

7. How many molecules are in a mole of ammonia, $\text{NH}_3$?
   a. 1
   b. 4
   c. $6.02 \times 10^{23}$
   d. $2.408 \times 10^{23}$
8. Which of the following is the correctly balanced equation for the complete combustion of methane, CH₄?
   a. CH₄(g) + O₂(g) → H₂O(g) + CO(g)
   b. CH₄(g) + O₂(g) → H₂O(g) + CO₂(g)
   c. 2CH₄(g) + 5O₂(g) → 4H₂O(g) + 2CO(g)
   d. CH₄(g) + 2O₂(g) → 2H₂O(g) + CO₂(g)

9. Nitrogen dioxide, NO₂, is a brown gas found in smog. It can produced by the reaction of nitric oxide, NO, with molecular oxygen in the air. Which of the following is the correctly balanced chemical equation for the reaction?
   a. NO(g) + O(g) → NO₂(g)
   b. NO(g) + O₂(g) → NO₂(g)
   c. 3NO(g) + O₃(g) → 3NO₂(g)
   d. 2NO(g) + O₂(g) → 2NO₂(g)

10. A classic method for generating molecular oxygen is the decomposition of potassium chlorate, KClO₃. The other product of this reaction is potassium chloride. Which of the following is the correctly balanced chemical equation for this reaction?
    a. KClO₃(s) → KCl(s) + 3O(g)
    b. 2KClO₃(s) → 2KCl(s) + 3O₂(g)
    c. KClO₃(s) → KCl(s) + O₃(g)
    d. 2KClO₃(s) → K₂Cl₂(s) + 3O₂(g)

11. For the reaction 2H₂ + O₂ → 2H₂O which of the following can be answered only using the coefficients of the balanced equation?
    a. What weight of water is produced when 2.5 grams of hydrogen react completely?
    b. What weight of water is produced when 2.5 moles of hydrogen react completely?
    c. How many moles of water are produced from 4.0 grams of hydrogen and 32.0 grams of oxygen?
    d. How many moles of water are produced when 2.5 moles of hydrogen react completely?

12. For the reaction 2KClO₃(s) → 2KCl(s) + 3O₂(g), how much oxygen is produced when 5.00 moles of starting material is completely decomposed?
    a. 3.33 moles
    b. 3.00 moles
    c. 5.00 moles
    d. 7.50 moles

13. What is the weight of the KCl residue when 3.00 grams of KClO₃(s) is decomposed according to the reaction 2KClO₃(s) → 2KCl(s) + 3O₂(g)?
    a. 0.193 g
    b. 1.37 g
    c. 1.83 g
    d. 2.74 g
14. The balanced equation for the complete combustion of propane is

\[ C_3H_8(g) + 5O_2(g) \rightarrow 4H_2O(g) + 3CO_2(g) \]

If 2 moles of propane and 10 moles of oxygen are placed in container, what will be left in the container after the reaction is complete?

a. 1 mole of propane, 5 moles of oxygen, 4 moles of water vapor, 3 moles of CO₂
b. no propane, no oxygen, 4 moles of water vapor, 3 moles of CO₂
c. no propane, no oxygen, 8 moles of water vapor, 6 moles of CO₂
d. none of the above combinations is correct

15. When ammonia gas comes in contact with hydrogen chloride gas the reaction is

\[ NH_3(g) + HCl(g) \rightarrow NH_4Cl(s) \]

What weight of ammonium chloride, NH₄Cl(s), is produced by the reaction of 34.0 grams of NH₃(g) with 75.0 grams of HCl(g)?

a. 34.0 g  
b. 75.0 g  
c. 107 g  
d. 109 g

16. A particular recipe can make 225 grams of chocolate frosting. However, the cook cannot get the last 5.00 grams out of the mixing bowl. What is the percentage yield of usable frosting?

a. 2.22%  
b. 5.00 %  
c. 97.8%  
d. 99.1%

17. When a hydrocarbon such as octane is burned in an automobile engine most of the carbon is converted to carbon dioxide but some carbon monoxide is also produced. The reaction for the complete combustion of octane is

\[ 2C_8H_{18}(g) + 25O_2(g) \rightarrow 18H_2O(g) + 16CO_2(g) \]

In a particular engine it is observed that when 114.0 grams of octane is burned 334 grams of CO₂(g) is produced. What is the percent yield of CO₂(g)?

a. 16.0%  
b. 44.0 %  
c. 94.9 %  
d. 98.9%

18. Which of the following is the balanced molecular equation for the reaction of silver nitrate, AgNO₃, with barium chloride, BaCl₂?

a. \( AgNO_3(aq) + BaCl_2(aq) \rightarrow AgCl(s) + BaNO_3(aq) \)

b. \( 2AgNO_3(aq) + BaCl_2(aq) \rightarrow 2AgCl(s) + BaNO_3(aq) \)

c. \( AgNO_3(aq) + BaCl_2(aq) \rightarrow AgCl_2(s) + BaNO_3(aq) \)

d. \( 2AgNO_3(aq) + BaCl_2(aq) \rightarrow 2AgCl(s) + Ba(NO_3)_2(aq) \)
19. Silver nitrate, AgNO₃, and sodium sulfide, Na₂S, are both soluble in water. When solutions of silver nitrate and sodium sulfide are mixed together sodium nitrate (which is soluble) and a black precipitate of solid silver sulfide, Ag₂S, is formed. Which of the following is the correct net ionic equation for this reaction?
   a. 2AgNO₃(s) + Na₂S(s) → 2NaNO₃(s) + Ag₂S(s)
   b. 2Ag⁺(aq) + 2NO₃⁻(aq) + 2Na⁺(aq) + S²⁻(aq) → 2Na⁺(aq) + 2NO₃⁻(aq) + 2Ag⁺(aq) + S²⁻(aq)
   c. 2Ag⁺(aq) + 2NO₃⁻(aq) + 2Na⁺(aq) + S²⁻(aq) → 2Na⁺(aq) + 2NO₃⁻(aq) + Ag₂S(s)
   d. 2Ag⁺(aq) + S²⁻(aq) → Ag₂S(s)

20. Barium chloride, BaCl₂, and sodium phosphate, Na₃PO₄, are both soluble in water, but barium phosphate is insoluble in water. When water is added to a mixture of barium chloride and sodium phosphate a white precipitate forms. Which of the following is the correct total ionic equation for the reaction which occurred?
   a. 3BaCl₂(s) + 2Na₃PO₄(s) → 6NaCl(s) + Ba₃(PO₄)₂(s)
   b. 3Ba²⁺(aq) + 6Cl⁻(aq) + 6Na⁺(aq) + PO₄³⁻(aq) → 6Na⁺(aq) + 6Cl⁻(aq) + 3Ba₂⁺(aq) + PO₄³⁻(aq)
   c. 3Ba²⁺(aq) + 6Cl⁻(aq) + 6Na⁺(aq) + 2PO₄³⁻(aq) → 6Na⁺(aq) + 6Cl⁻(aq) + Ba₃(PO₄)₂(s)
   d. 3Ba²⁺(aq) + 6Cl⁻(aq) → Ba₃(PO₄)₂(s)

21. Barium chloride, BaCl₂, and sodium phosphate, Na₃PO₄, are both soluble in water, but barium phosphate is insoluble in water. When water is added to a mixture of barium chloride and sodium phosphate a white precipitate forms. Which of the following is the correct net ionic equation for the reaction which occurred?
   a. 3BaCl₂(s) + 2Na₃PO₄(s) → 6NaCl(s) + Ba₃(PO₄)₂(s)
   b. 3Ba²⁺(aq) + 6Cl⁻(aq) + 6Na⁺(aq) + PO₄³⁻(aq) → 6Na⁺(aq) + 6Cl⁻(aq) + 3Ba₂⁺(aq) + PO₄³⁻(aq)
   c. 3Ba²⁺(aq) + 6Cl⁻(aq) + 6Na⁺(aq) + PO₄³⁻(aq) → 6Na⁺(aq) + 6Cl⁻(aq) + Ba₃(PO₄)₂(s)
   d. 3Ba²⁺(aq) + 2PO₄³⁻(aq) → Ba₃(PO₄)₂(s)

22. Which of the following type of materials will react with sodium bicarbonate, NaHCO₃, to produce a gas?
   a. acids
   b. bases
   c. salts
   d. all of them

23. Which of the following can serve as the driving force for a chemical reaction?
   a. formation of a gas
   b. formation of a precipitate
   c. both (a) and (b)
   d. neither (a) nor (b)

24. Which of the following ions is always a spectator ion?
   a. C₂H₃O₂⁻
   b. CO₃²⁻
   c. OH⁻
   d. S²⁻

25. Which of the following is usually, but not always, a spectator ion?
   a. Cl⁻
   b. SO₄²⁻
   c. both (a) and (b)
   d. neither (a) nor (b)
26. Which of the following is usually not a spectator ion?
a. NH₄⁺
b. C₂H₃O₂⁻
c. S²⁻
d. SO₄²⁻

27. Oxidation can be defined as which of the following?
a. gain of oxygen
b. loss of electrons
c. loss of hydrogen
d. all of these correctly define oxidation

28. Oxidation can be defined as which of the following?
a. loss of oxygen
b. loss of electrons
c. gain of hydrogen
d. all of these correctly define oxidation

29. In a redox reaction which of the following is true for the oxidizing agent?
a. it accepts electrons
b. it is reduced
c. both (a) and (b) are true
d. both (a) and (b) are false

30. In a redox reaction which of the following is true for the oxidizing agent?
a. it donates electrons
b. it is reduced
c. both (a) and (b) are true
d. both (a) and (b) are false

31. In a redox reaction which of the following is true for the reducing agent?
a. it accepts electrons
b. it is oxidized
c. both (a) and (b) are true
d. both (a) and (b) are false

32. Which of the following is true about the combustion of a hydrocarbon?
a. combustion is not a redox reaction
b. oxygen is the oxidizing agent
c. the hydrocarbon is the oxidizing agent
d. all of these are true

33. Which of the following is true about the combustion of a hydrocarbon?
a. combustion is not redox reaction
b. oxygen is reduced
c. the hydrocarbon is reduced
d. all of these are true

34. Which of the following is not an example of a redox reaction?
a. bleaching
b. precipitation
c. respiration
d. rusting
35. When a piece of solid magnesium is added to an hydrochloric acid the total ionic for the reaction is

\[ \text{Mg}(s) + 2\text{H}^+(aq) + 2\text{Cl}^-(aq) \rightarrow \text{Mg}^{2+}(aq) + 2\text{Cl}^-(aq) + \text{H}_2(g) \]

Which of the following is true for this reaction?

a. the chloride ion is oxidized  
b. the magnesium metal is reduced  
c. both (a) and (b) are true  
d. neither (a) nor (b) is true

36. When a piece of solid magnesium is added to an hydrochloric acid the total ionic for the reaction is

\[ \text{Mg}(s) + 2\text{H}^+(aq) + 2\text{Cl}^-(aq) \rightarrow \text{Mg}^{2+}(aq) + 2\text{Cl}^-(aq) + \text{H}_2(g) \]

Which of the following is true for this reaction?

a. the hydrogen ion is oxidized  
b. the magnesium metal is reduced  
c. both (a) and (b) are true  
d. neither (a) nor (b) is true

37. Which of the following is true of a reaction in which heat is produced?

a. the reaction is endothermic  
b. the reaction is exothermic  
c. depending on the reaction the reaction may be either endothermic or exothermic  
d. there are more products than reactants

38. Which of the following is true of all combustion reactions?

a. they are all endothermic  
b. they are all exothermic  
c. they all produce carbon dioxide  
d. there is no single characteristic of all combustion reactions

39. Iron ore is converted to iron by heating it with coal, C, and oxygen according to the following equation:

\[ 2\text{Fe}_2\text{O}_3(s) + 6\text{C}(s) + 3\text{O}_2(s) \rightarrow 4\text{Fe}(s) + 6\text{CO}_2(s) \]

If the process is run until 3940. gram of Fe is produced, how many grams of CO\(_2\) will also be produced?

a. 3.275 grams CO\(_2\)  
b. 32.57 grams CO\(_2\)  
c. 325.7 grams CO\(_2\)  
d. 3257 grams CO\(_2\)

40. Aspirin is made by the reaction of salicylic acid with acetic anhydride. How many grams of aspirin are produced if 85.0 grams of salicylic acid is treated with an excess of acetic anhydride? Given the following:

\[ \text{C}_7\text{H}_6\text{O}_3(s) + \text{C}_4\text{H}_6\text{O}_3(l) \rightarrow \text{C}_9\text{H}_8\text{O}_4(s) + \text{C}_2\text{H}_4\text{O}_2(l) \]

Salicylic acid  Acetic anhydride  Aspirin  Acetic Acid

a. 111 gram aspirin  
b. 24 gram aspirin  
c. 135 gram aspirin  
d. 91 gram aspirin