CHAPTER REVIEW

Describing Chemical Reactions

SECTION 1 REVIEW

1. List four observations that indicate that a chemical reaction may be taking place.
2. List the three requirements for a correctly written chemical equation.
3. a. What is meant by the term *coefficient* in relation to a chemical equation?
   b. How does the presence of a coefficient affect the number of atoms of each type in the formula that the coefficient precedes?
4. Give an example of a word equation, a formula equation, and a chemical equation.
5. What quantitative information is revealed by a chemical equation?
6. What limitations are associated with the use of both word and formula equations?
7. Define each of the following terms:
   a. aqueous solution
   b. catalyst
   c. reversible reaction
8. Write formulas for each of the following compounds:
   a. potassium hydroxide
   b. calcium nitrate
   c. sodium carbonate
   d. carbon tetrachloride
   e. magnesium bromide
9. What four guidelines are useful in balancing an equation?
10. How many atoms of each type are represented in each of the following?
    a. $3N_2$
    b. $2H_2O$
    c. $4HNO_3$
    d. $2Ca(OH)_2$
    e. $3Ba(ClO_3)_2$
    f. $5Fe(NO_3)_2$
    g. $4Mg_3(PO_4)_2$
    h. $2(NH_4)_2SO_4$
    i. $6Al_2(SeO_4)_3$
    j. $4C_3H_8$

PRACTICE PROBLEMS

11. Write the chemical equation that relates to each of the following word equations. Include symbols for physical states in the equation.
    a. solid zinc sulfide + oxygen gas ⟶ solid zinc oxide + sulfur dioxide gas
    b. aqueous hydrochloric acid + aqueous barium hydroxide ⟶ aqueous barium chloride + water
    c. aqueous nitric acid + aqueous calcium hydroxide ⟶ aqueous calcium nitrate + water
12. Translate each of the following chemical equations into a sentence.
    a. $2ZnS(s) + 3O_2(g) \longrightarrow 2ZnO(s) + 2SO_2(g)$
    b. $CaH_2(s) + 2H_2O(l) \longrightarrow Ca(OH)_2(aq) + 2H_2(g)$
    c. $AgNO_3(aq) + KI(aq) \longrightarrow AgI(s) + KNO_3(aq)$
13. Balance each of the following:
    a. $H_2 + Cl_2 \longrightarrow HCl$
    b. $Al + Fe_2O_3 \longrightarrow Al_2O_3 + Fe$
    c. $Pb(CH_3COO)_2 + H_2S \longrightarrow PbS + CH_3COOH$
14. Identify and correct each error in the following equations, and then balance each equation.
    a. $Li + O_2 \longrightarrow LiO_2$
    b. $H_2 + Cl_2 \longrightarrow H_2Cl_2$
    c. $MgCO_3 \longrightarrow MgO_2 + CO_2$
    d. $NaI + Cl_2 \longrightarrow NaCl + I$
15. Write chemical equations for each of the following sentences:
    a. Aluminum reacts with oxygen to produce aluminum oxide.
    b. Phosphoric acid, H_3PO_4, is produced through the reaction between tetraphosphorus decoxide and water.
    c. Iron(III) oxide reacts with carbon monoxide to produce iron and carbon dioxide.
16. Carbon tetrachloride is used as an intermediate chemical in the manufacture of other chemicals. It is prepared in liquid form by reacting chlorine gas with methane gas. Hydrogen chloride gas is also formed in this reaction. Write the balanced chemical equation for the production of carbon tetrachloride. (Hint: See Sample Problems C and D.)

17. For each of the following synthesis reactions, identify the missing reactant(s) or product(s), and then balance the resulting equation.
a. $Mg + \_\_\_\_\_ \longrightarrow MgO$
b. $\_\_\_\_\_ + O_2 \longrightarrow Fe_2O_3$
c. $Li + Cl_2 \longrightarrow \_\_\_\_\_$
d. $Ca + \_\_\_\_\_ \longrightarrow CaI_2$

Types of Chemical Reactions

SECTION 2 REVIEW

18. Define and give general equations for the five basic types of chemical reactions introduced in Chapter 8.
19. How are most decomposition reactions initiated?
20. A substance is decomposed by an electric current. What is the name of this type of reaction?
21. a. In what environment do many single-displacement reactions commonly occur?
b. In general, how do single-displacement reactions compare with synthesis and decomposition reactions in terms of the amount of energy involved?

PRACTICE PROBLEMS

22. Complete each of the following synthesis reactions by writing both a word equation and a chemical equation.
a. sodium + oxygen $\longrightarrow$ _____
b. magnesium + fluorine $\longrightarrow$ _____
23. Complete and balance the equations for the following decomposition reactions:
a. $HgO \xrightarrow{\Delta}$
b. $H_2O(l) \xrightarrow{\text{electricity}}$
c. $Ag_2O \xrightarrow{\Delta}$
d. $CuCl_2 \xrightarrow{\text{electricity}}$

24. Complete and balance the equations for the following single-displacement reactions:
a. $Zn + Pb(NO_3)_2 \longrightarrow \_\_\_\_\_$
b. $Al + Hg(CH_3COO)_2 \longrightarrow \_\_\_\_\_$
c. $Al + NiSO_4 \longrightarrow \_\_\_\_\_$
d. $Na + H_2O \longrightarrow \_\_\_\_\_$
25. Complete and balance the equations for the following double-displacement reactions:
a. $AgNO_3(aq) + NaCl(aq) \longrightarrow \_\_\_\_\_$
b. $Mg(NO_3)_2(aq) + KOH(aq) \longrightarrow \_\_\_\_\_$
c. $LiOH(aq) + Fe(NO_3)_3(aq) \longrightarrow \_\_\_\_\_$
26. Complete and balance the equations for the following combustion reactions:
a. $CH_4 + O_2 \longrightarrow \_\_\_\_\_$
b. $C_3H_6 + O_2 \longrightarrow \_\_\_\_\_$
c. $C_5H_{12} + O_2 \longrightarrow \_\_\_\_\_$
27. Write and balance each of the following equations, and then identify each by type.
a. hydrogen + iodine $\longrightarrow$ hydrogen iodide
b. lithium + hydrochloric acid $\longrightarrow$ lithium chloride + hydrogen
c. sodium carbonate $\longrightarrow$ sodium oxide + carbon dioxide
d. mercury(II) oxide $\longrightarrow$ mercury + oxygen
e. magnesium hydroxide $\longrightarrow$ magnesium oxide + water
28. Identify the compound that could undergo decomposition to produce the following products, and then balance the final equation.
a. magnesium oxide and water
b. lead(II) oxide and water
c. lithium chloride and oxygen
d. barium chloride and oxygen
e. nickel chloride and oxygen
29. In each of the following combustion reactions, identify the missing reactant(s), product(s), or both, and then balance the resulting equation.
a. $C_3H_8 + \_\_\_\_\_ \longrightarrow \_\_\_\_\_ + H_2O$
b. $\_\_\_\_\_ + 8O_2 \longrightarrow 5CO_2 + 6H_2O$
c. $C_2H_5OH + \_\_\_\_\_ \longrightarrow \_\_\_\_\_ + \_\_\_\_\_$
30. Complete and balance the equations for the following reactions, and then identify each by type.
a. zinc + sulfur $\longrightarrow$ _____
b. silver nitrate + potassium iodide $\longrightarrow$ _____
c. toluene, C_7H_8 + oxygen $\longrightarrow$ _____
d. nonane, C_9H_{20} + oxygen $\longrightarrow$ _____

Activity Series of the Elements

SECTION 3 REVIEW

31. a. What is meant by the *activity* of an element?
b. How does this description differ for metals and nonmetals?

32. a. What is an activity series of elements?
b. What is the basis for the ordering of the elements in the activity series?

33. a. What chemical principle is the basis for the activity series of metals?
b. What is the significance of the distance between two metals in the activity series?

PRACTICE PROBLEMS

34. Based on the activity series of metals and halogens, which element within each pair is more likely to replace the other in a compound?
a. K and Na
b. Al and Ni
c. Bi and Cr
d. Cl and F
e. Au and Ag
f. Cl and I
g. Fe and Sr
h. I and F

35. Using the activity series in **Table 3** on page 286, predict whether each of the possible reactions listed below will occur. For the reactions that will occur, write the products and balance the equation.
a. $Ni(s) + CuCl_2(aq) \longrightarrow$ _____
b. $Zn(s) + Pb(NO_3)_2(aq) \longrightarrow$ _____
c. $Cl_2(g) + KI(aq) \longrightarrow$ _____
d. $Cu(s) + FeSO_4(aq) \longrightarrow$ _____
e. $Ba(s) + H_2O(l) \longrightarrow$ _____

36. Use the activity series to predict whether each of the following synthesis reactions will occur, and write the chemical equations for those predicted to occur.
a. $Ca(s) + O_2(g) \longrightarrow$ _____
b. $Ni(s) + O_2(g) \longrightarrow$ _____
c. $Au(s) + O_2(g) \longrightarrow$ _____

MIXED REVIEW

37. Ammonia reacts with oxygen to yield nitrogen and water.

$4NH_3(g) + 3O_2(g) \longrightarrow 2N_2(g) + 6H_2O(l)$

Given this chemical equation, as well as the number of moles of the reactant or product indicated below, determine the number of moles of all remaining reactants and products.
a. 3.0 mol O_2
b. 8.0 mol NH_3
c. 1.0 mol N_2
d. 0.40 mol H_2O

38. Complete the following synthesis reactions by writing both the word and chemical equation for each:
a. potassium + chlorine $\longrightarrow$ _____
b. hydrogen + iodine $\longrightarrow$ _____
c. magnesium + oxygen $\longrightarrow$ _____

39. Use the activity series to predict which metal—Sn, Mn, or Pt—would be the best choice as a container for an acid.

40. Aqueous sodium hydroxide is produced commercially by the electrolysis of aqueous sodium chloride. Hydrogen and chlorine gases are also produced. Write the balanced chemical equation for the production of sodium hydroxide. Include the physical states of the reactants and products.

41. Balance each of the following:
a. $Ca(OH)_2 + (NH_4)_2SO_4 \longrightarrow CaSO_4 + NH_3 + H_2O$
b. $C_2H_6 + O_2 \longrightarrow CO_2 + H_2O$
c. $Cu_2S + O_2 \longrightarrow Cu_2O + SO_2$
d. $Al + H_2SO_4 \longrightarrow Al_2(SO_4)_3 + H_2$

42. Use the activity series to predict whether each of the following reactions will occur, and write the balanced chemical equations for those predicted to occur.
a. $Al(s) + O_2(g) \longrightarrow$ _____
b. $Pb(s) + ZnCl_2(s) \longrightarrow$ _____

43. Complete and balance the equations for the following reactions, and identify the type of reaction that each equation represents.
a. $(NH_4)_2S(aq) + ZnCl_2(aq) \longrightarrow$ _____ $+ ZnS(s)$
b. $Al(s) + Pb(NO_3)_2(aq) \longrightarrow$ _____
c. $Ba(s) + H_2O(l) \longrightarrow$ _____
d. $Cl_2(g) + KBr(aq) \longrightarrow$
e. $NH_3(g) + O_2(g) \xrightarrow{Pt} NO(g) + H_2O(l)$
f. $H_2O(l) \longrightarrow H_2(g) + O_2(g)$

44. Write and balance each of the following equations, and then identify each by type.
a. copper + chlorine $\longrightarrow$ copper(II) chloride
b. calcium chlorate $\longrightarrow$ calcium chloride + oxygen
c. lithium + water $\longrightarrow$ lithium hydroxide + hydrogen
d. lead(II) carbonate $\longrightarrow$ lead(II) oxide + carbon dioxide

45. How many moles of HCl can be made from 6.15 mol H_2 and an excess of Cl_2?

46. What product is missing in the following equation?

$$MgO + 2HCl \longrightarrow MgCl_2 + \_\_\_\_\_$$

47. Balance the following equations:

a. $Pb(NO_3)_2(aq) + NaOH(aq) \longrightarrow Pb(OH)_2(s) + NaNO_3(aq)$

b. $C_{12}H_{22}O_{11}(l) + O_2(g) \longrightarrow CO_2(g) + H_2O(l)$

c. $Al(OH)_3(s) + H_2SO_4(aq) \longrightarrow Al_2(SO_4)_3(aq) + H_2O(l)$

CRITICAL THINKING

48. Inferring Relationships Activity series are prepared by comparing single-displacement reactions between metals. Based on observations, the metals can be ranked by their ability to react. However, reactivity can be explained by the ease with which atoms of metals lose electrons. Using information from the activity series, identify the locations in the periodic table of the most reactive metals and the least reactive metals. Using your knowledge of electron configurations and periodic trends, infer possible explanations for the metals' reactivity and position in the periodic table.

49. Analyzing Results Formulate an activity series for the hypothetical elements A, J, Q, and Z by using the following reaction information:

$$A + ZX \longrightarrow AX + Z$$

$$J + ZX \longrightarrow \text{no reaction}$$

$$Q + AX \longrightarrow QX + A$$

USING THE HANDBOOK

50. Find the common-reactions section for Group 1 metals in the *Elements Handbook*. Use this information to answer the following:

a. Write a balanced chemical equation for the formation of rubidium hydroxide from rubidum oxide.

b. Write a balanced chemical equation for the formation of cesium iodide.

c. Classify the reactions you wrote in (a) and (b).

d. Write word equations for the reactions you wrote in (a) and (b).

51. Find the common-reactions section for Group 13 in the *Elements Handbook*. Use this information to answer the following:

a. Write a balanced chemical equation for the formation of gallium bromide prepared from hydrobromic acid.

b. Write a balanced chemical equation for the formation of gallium oxide.

c. Classify the reactions you wrote in (a) and (b).

d. Write word equations for the reactions you wrote in (a) and (b).

RESEARCH & WRITING

52. Trace the evolution of municipal water fluoridation. What advantages and disadvantages are associated with this practice?

53. Research how a soda-acid fire extinguisher works, and write the chemical equation for the reaction. Check your house and other structures for different types of fire extinguishers, and ask your local fire department to verify the effectiveness of each type of extinguisher.

ALTERNATIVE ASSESSMENT

54. Performance Assessment For one day, record situations that show evidence of a chemical change. Identify the reactants and the products, and determine whether there is proof of a chemical reaction. Classify each of the chemical reactions according to the common reaction types discussed in the chapter.