Chapter 5 Summary

5.1 Synthesis and Decomposition Reactions

Key Concepts

- Evidence of a chemical change may include one or more of the following: formation of a gas, formation of a precipitate, change in odour, change in colour, change in temperature, and production of light.
- During a synthesis reaction, two or more reactants combine to form one product. The general chemical equation for a synthesis reaction is $A + B \rightarrow AB$. The reactants may be any combination of elements and compounds, but the product will always be a compound. Examples of synthesis reactions include the formation of rust and the production of ammonia.
- During a decomposition reaction, a single reactant breaks down to form two or more products. The general chemical equation for a decomposition reaction is $AB \rightarrow A + B$. The products may be any combination of elements and compounds, but the reactant will always be a compound. Important decomposition reactions include the electrolysis of water and the explosion of TNT.

5.2 Displacement Reactions

Key Concepts

- In a single displacement reaction, a metal replaces the ion of a different metal, or a non-metal replaces the ion of a non-metal. The products are an element and a compound that differ from the reactants.
- An activity series is a list of elements arranged in order from the most reactive to the least reactive. For a single displacement reaction to happen, a more reactive element must replace the ions of a less reactive element.
- During a double displacement reaction between two compounds in aqueous solutions, the cations of the two compounds switch places to form two new compounds. For a certain type of double displacement reaction, one of the products is a precipitate.

5.3 Reactions and Environmental Issues

Key Concepts

- Catalytic converters are used to help combat pollutants from car exhausts. They act by decomposing nitrogen oxides in exhaust into the elements nitrogen and oxygen.
- The gold mining process relies a great deal on chemistry. Gold forms a soluble substance with cyanide ions. Zinc displaces the gold so that the metal can be recovered. The use of cyanide containing chemicals, however, results in several environmental challenges.
- Bleach and other chlorine-based chemicals are used as disinfectants. Improper handling and mixing with other chemicals, such as ammonia, can result in reactions that produce toxic gases.
- Users of a product can find information on how to handle and use it safely by examining the safety precautions and symbols on the product's label. For laboratory and workplace materials, WHMIS symbols are used. For consumer products, the HHPS system is used.

Chapter 5 Review

Make Your Own Summary

Summarize the key concepts of this chapter using a graphic organizer. The Chapter Summary on the previous page will help you identify the key concepts. Refer to Study Toolkit 4 on pages 565–566 to help you decide which graphic organizer to use.

Reviewing Key Terms

1. An element taking the place of a less active element in a compound occurs during a _____. (5.2)

2. If a chemical reaction forms a single product from more than one reactant, the reaction is a _____. (5.1)

3. A substance that increases the rate of a chemical reaction but is not used up in the reaction is a _____. (5.3)

4. A single reactant breaks down into more than one product during a _____. (5.1)

5. A solid that forms during the reaction of two aqueous solutions is a _____. (5.1)

6. You can predict whether a single displacement reaction will occur by looking at a list of elements organized according to their chemical reactivity, known as an _____. (5.2)

7. A chemical reaction that involves the switching of ions between two compounds to form two new compounds is a _____. (5.2)

Knowledge and Understanding K/U

8. List six types of evidence of a chemical reaction.

9. What is the balanced chemical equation for the reaction that provides thrust to a space shuttle? What type of reaction is it?

10. Identify the type of reaction that is represented by each of the following chemical equations.

a. $12KCl(aq) + Pb_3(PO_4)_4(aq) \rightarrow 3PbCl_4(s) + 4K_3PO_4(aq)$

b. $MnI_4(s) \rightarrow Mn(s) + 2I_2(s)$

c. $3Mg(s) + N_2(g) \rightarrow Mg_3N_2(s)$

d. $Cu(s) + 2AgNO_3(aq) \rightarrow 2Ag(s) + Cu(NO_3)_2(aq)$

e. $2NaClO_3(s) \rightarrow 2NaCl(s) + 3O_2(g)$

f. $S_8(s) + 12O_2(g) \rightarrow 8SO_3(g)$

11. Identify all reaction types that fit each description below.

a. includes at least one element as a reactant

b. has a single substance as the reactant

c. has only ionic compounds as reactants and products

12. Determine whether each of the following single displacement reactions will occur. If the reaction will occur, write the products and balance the chemical equation.

a. $Li(s) + NaCl(aq) \rightarrow$

b. $Al(s) + Cu(NO_3)_2(aq) \rightarrow$

c. $Fe(s) + ZnCl_2(aq) \rightarrow$

13. For each of the following reactants, identify the type of reaction that will occur. Explain your reasoning.

a. $Cl_2(g) + CaBr_2(aq) \rightarrow$

b. $Li(s) + N_2(g) \rightarrow$

c. $AgNO_3(aq) + NaCl(aq) \rightarrow$

d. $PbO_2(s) \rightarrow$

e. $Fe(ClO_4)_2(aq) + Al(s) \rightarrow$

f. $Ba(NO_3)_2(aq) + MgSO_4(aq) \rightarrow$

g. $BaCl_2(aq) + Na_2CrO_4(aq) \rightarrow$

h. $Rb(s) + O_2(g) \rightarrow$

i. $I_2(s) + CaBr_2(aq) \rightarrow$

j. $Mg(s) + S_8(s) \rightarrow$

14. For each reaction in question 13, determine the products that are most likely to occur and write a balanced chemical equation. You do not need to indicate the states of the products. For any single displacement reaction that does not occur, write "no reaction."

15. Why is the formation of a precipitate an important piece of evidence of a double displacement reaction?

Thinking and Investigation T/I

16. Examine the photograph and write a detailed description of the reaction that is taking place, including evidence of a reaction and what type of reaction it is likely to be.

A chemical reaction is taking place.

17. Gasoline is a fossil fuel that is a mixture of chemicals, many of which have the formula C_8H_{18}. When these chemicals burn, they react with oxygen gas to form carbon dioxide and water vapour. Write a balanced chemical equation for this reaction. Analyze the reactants and products of the reaction, and explain why it does not fit any of the four types of reactions covered in this chapter.

18. How would you classify the reaction in which zinc powder is used to recover gold? Which reaction type does this reaction most resemble? Explain your reasoning.

19. While cleaning the bathroom with different cleaning products, a friend complains of a strong irritating odour. What could have happened, and should your friend be concerned?

Communication C

20. Develop a method to model synthesis and decomposition reactions. Write an illustrated set of instructions to describe your model.

21. Analyze the safety and environmental issues related to the chemicals listed below. Using information sources such as MSDS and WHMIS, identify potential hazards, incompatible combinations, and safety precautions required when working with each chemical in a laboratory. Then research the safety precautions and warning labels used on consumer products that contain each chemical. Summarize your findings in the form of an information pamphlet for consumers.

a. lye (often found in drain cleaners)

b. ammonia (often used in window cleaners)

22. Describe when a single displacement reaction will not occur using a diagram of the activity series.

23. BIG IDEAS Chemicals react with each other in predictable ways. Create a flowchart that can be used to identify which of the four types of reactions a particular reaction is, when you are given only the reactants.

24. BIG IDEAS Chemical reactions may have a negative impact on the environment, but they can also be used to address environmental challenges. Suppose that you are a specialist in charge of deciding how to clean up an oil spill. You have the following options: let nature take its course, use biological agents, use a controlled burn, use chemicals to disperse the oil, and skim the oil off the surface.

Part of your job is to communicate your method(s) of choice to stakeholders. Research the benefits and drawbacks of each method, and describe the advantages and disadvantages that you would communicate to a coastal community that will be affected by the oil spill.

Application A

25. While working as a laboratory technician, you notice that the MSDS records are over five years old. What could you say to your manager to help convey the importance of maintaining up-to-date MSDS records?

26. Describe why it is important that the catalytic converter contain a catalyst rather than a material that would react with the compounds in a car's exhaust.

27. Large oil spills are often featured on the news and get a large amount of attention. Should there be a system to monitor much smaller spills? Explain.