Chapter 6.13- Rev.

6.13 Activity

Putting It All Together

You have learned that chemical reactions can be grouped into various categories. The system we have used looks at the reactants. Are they elements or compounds? Are they metals or nonmetals? In this activity, you will make a graphic organizer to summarize your knowledge of the types of chemical reactions.

Materials

- scissors
- paper
- coloured markers
- glue stick

Procedure

1 (X) Your teacher will put you into cooperative groups. Your teacher may also decide to assign you specific roles, such as Writer, Textbook Resource, or Materials Manager.

2 Cut out 30 small pieces of paper, each roughly a 2-cm × 4-cm rectangle. Write the following words on the rectangles, using your choice of appropriate coloured markers:

- "element" on 6 rectangles
- "compound" on 12 rectangles
- "smaller compound" on 4 rectangles
- "larger compound" on 2 rectangles
- "metal" on 2 rectangles
- "nonmetal" on 4 rectangles

(a) What are the meanings of the terms "element" and "compound"?
(b) What are several examples of elements and compounds?
(c) What are the meanings of the terms "metal" and "nonmetal"?
(d) What are several examples of metals and nonmetals?

3 Cut out 8 smaller rectangles, and draw an arrow on each rectangle. This arrow links reactants and products in chemical equations. Cut out 12 to 15 very small squares on which you can write a plus (+) sign to use in building some equations.

4 Review the four types of chemical reactions that you have encountered in this chapter. Cut out 4 large rectangles; on each of these rectangles, write in block capitals the name of one type of reaction (Synthesis, Decomposition, Single Displacement, or Double Displacement).

5 Write the heading "Types of Chemical Reactions" on a piece of paper. Place the labels for the types of reactions in different areas of the sheet. For example, below the "Synthesis" label, place words in different combinations that summarize the information you have learned about synthesis reactions (**Figure 1**). Make sure you leave some space underneath each of the labels.

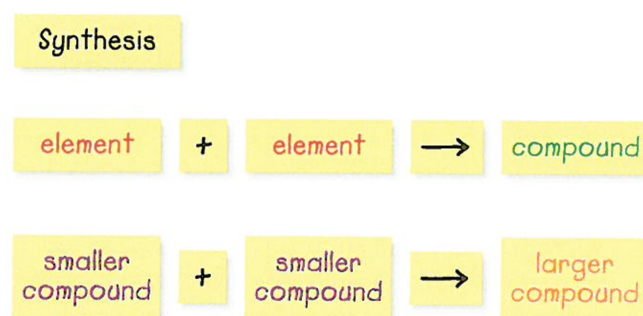

Figure 1

SKILLS HANDBOOK: (X) Working Together

Repeat step 5 for the other three types of reactions, using the remaining words. Feel free to organize the words as you choose and to make other labels if they seem appropriate.

7 Underneath or beside each set of labels, add other information that may help you to summarize what you know about these reactions. For example, **Figure 2** shows some additional possible information about synthesis reactions.

8 Organize the labels so that they provide the most efficient summary of what you know about these types of reactions. Glue the rectangles in place.

9 Save this chart for later use.

Understanding Concepts

1. What do synthesis and single displacement reactions have in common?
2. What do decomposition and double displacement reactions have in common?
3. Which two types of reactions seem to be opposites? Explain.
4. Identify each of the following reactions as one of the four types of reactions:
   - **(a)** barium + sulfur → barium sulfide
   - **(b)** bromine + sodium iodide → iodine + sodium bromide
   - **(c)** barium nitrate + sodium sulfide → barium sulfide + sodium nitrate
   - **(d)** lithium carbonate → carbon dioxide + lithium oxide
   - **(e)** lead(II) oxide → lead + oxygen
   - **(f)** calcium + water → hydrogen + calcium hydroxide
   - **(g)** sulfur trioxide + water → sulfuric acid
5. Write skeleton and balanced chemical equations for each of the reactions in question 4.
6. Where would you put combustion reactions in your chart? Explain.

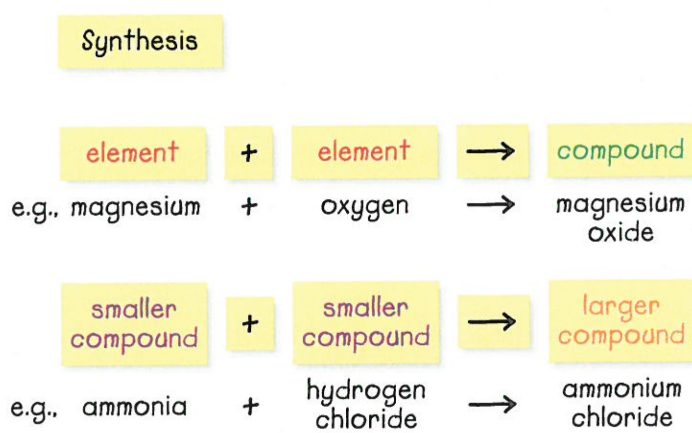

Figure 2

6.14 Explore an Issue

DECISION MAKING SKILLS
- ● Define the Issue
- ○ Identify Alternatives
- ● Research
- ● Analyze the Issue
- ● Defend a Decision
- ○ Evaluate

Is Pollution Necessary?

Have you ever considered how your lifestyle may affect the environment? When you or your family buys a product, whether it is a durable product such as a computer or a disposable product such as a magazine, what you buy affects the environment. Heating your house, running your computer, and travelling in a car all require energy. What kind of balance should exist between your lifestyle and concerns about the environment?

Canadians enjoy a high standard of living. However, maintaining such a high quality of life has negative effects on the environment. Using energy to power appliances or automobiles, buying products, and disposing of packaging and useless or worn goods are all individual choices that produce pollution.

Energy production and use are the major sources of air pollution. Canadians use more energy per person than people in most other countries. There are several reasons for this: Canada has a cold climate, a large industrial base that consumes 31% of the energy produced, and a large land area over which to transport goods and people. Almost 70% of Canadian energy requirements are supplied by burning fossil fuels. The burning of fossil fuels releases air pollutants, such as carbon dioxide, nitrogen oxides, and sulfur dioxide. Toxic air pollutants, such as benzene, are released during the handling and storage of fossil fuels.

Consumer products and packaging create wastes. It is estimated that over 300 kg of household waste is produced per person each year. Our choices of products, such as batteries, paints, and pesticides, contribute to hazardous wastes. The typical Canadian household produces 6.8 kg of hazardous waste per year.

However, consumer products are important. Buying products is important to the economy; manufacturing industries provide jobs (**Figure 1**). Appliances, such as microwave ovens and dishwashers, make our lives easier and more time-efficient. Materials can be reused, recycled, or repaired. Transportation of products around Canada ensures that everyone has access to the products.

Figure 1

Factories may produce pollution, but they also provide jobs and make useful products.

Work the Web

Explore the effects of pollution on the environment by following the Science 10, 6.14 links at www.science.nelson.com.

Understanding the Issue

1. Suggest some sources of pollution that are related to our high standard of living.
2. How do Ontario's geography and climate affect our consumption of energy?
3. What types of products could you choose that would help reduce the effects of pollution?

SKILLS HANDBOOK: Ⓨ Graphic Organizers

Economist Says Pollution No Problem

Alex Leroy, an internationally known economist, spoke to the Chamber of Commerce yesterday on the need for a growing economy.

"The manufacturing sector is a powerful economic force, creating products that people need, and providing economic growth, jobs, and income. Consumer products are necessary for an expanding population. Without gasoline-powered vehicles, our economy would literally grind to a halt.

"I believe that pollution is not a problem. Some pollution is unavoidable, but controls are in place to keep this pollution to a minimum. In fact, the environment is improving. Proper disposal of hazardous wastes can minimize the effect these materials have on the environment. Packaging foods not only protects the product and preserves freshness, but ensures that only 2% of food is wasted before reaching the customer. And recycling is working: approximately 50% of all iron and steel produced in Canada comes from recycled iron and steel scrap. In a way, pollution even stimulates the economy by directly providing jobs through its cleanup. New technologies have led to the development of more energy-efficient appliances. Industries, logging, mining, construction, agriculture, and transportation all are vital to our standard of living, and are controlled to limit their environmental impact."

Figure 2

Environmentalist Says Quality of Life Threatened

Sandy Green, spokesperson for the "Save Our World" group, spoke at a rally at City Hall yesterday.

"We need to change our attitudes about progress and growth in the economy. People think that 'standard of living' means how big their car is or how many televisions they own. But a good standard of living includes having clean air, soil, and water. Pollution is threatening our quality of life.

Industries pump poisonous gases into the air. We consume and waste energy at an alarming rate. Cars are a major source of air pollution: in Canada, there is approximately one car for every two people. Nuclear power plants produce nuclear wastes, that we can't dispose of, and fossil fuel-burning power plants contaminate the air with pollutants that contribute to global warming and acid rain. The excess packaging of products consumes materials such as glass, cardboard, and metals, uses energy in production, and creates waste.

"There are many alternatives. We should be reducing our levels of energy consumption, recycling materials, and reusing products. We should be using natural materials rather than synthetics. We should be using public transportation, rather than driving everywhere. Did you know that one bus replaces about 44 cars? We should be carefully thinking about the goods that we buy and how our choices can save the environment."

Figure 3

Take a Stand — Perspectives on Pollution and the Standard of Living

The issue of pollution and our standard of living is a complex one. Newspapers, magazines, and other media usually present definite points of view. Some articles may be "pro-business," while others may be "pro-environment." Read the views presented in **Figures 2 and 3**.

1. Working in a group, brainstorm as many (Y) ideas about the issue as possible and record (D) your ideas in a P-M-I graphic organizer. The newspaper articles will give you some hints, but use your own knowledge and imagination to add your own ideas. Plus (P) comments describe benefits and positive effects of processes that produce pollution. Minus (M) comments describe problems and negative effects of pollution. Interesting Questions (I) describe what the group would like to know about the topic to help make a decision. As a group, decide which view you support.
2. Using libraries, the Internet, and CD (E) references, research to find information that will further support both sides of the issue.
3. Write a short play in which a group of friends is discussing what they choose to buy with their part-time wages. If possible, stage your play.

(D) Identifying Alternatives (E) Researching Alternatives

6.15 Career Profile

Ann Tran

Hospital Pharmacist

When a patient is connected to several IV (intravenous) drips in a hospital, the last thing on her mind is whether the various chemicals are going to do something nasty in her body. Ann Tran's job is to make sure that doesn't happen. "If you're not careful," she says, "you can put a patient on two drips that will react to form a precipitate. The chemicals then will not have the effect intended, and the precipitate may very well be poisonous." Certainly not what the doctor ordered!

Ann is a hospital pharmacist. She emigrated to Canada from Vietnam at the age of 2 with her mother (a teacher) and her father (a mechanical engineer at the Riverdale Hospital in Toronto). Ann worked weekends as a teenager in her aunt's pharmacy and as a summer student at the Riverdale hospital. Despite her aunt's reassurance that pharmacy is a great career "because most pharmacists keep regular hours," Ann found herself drawn to a practice in hospital pharmacy, where the hours are anything but regular, but the reward comes from the thrill of observing treatment firsthand.

Ann graduated from the University of Toronto with a Bachelor of Science in pharmacy and promptly did a clinical pharmacy residency at the Sunnybrook and Women's College Health Sciences Centre.

In her capacity as staff pharmacist in general surgery at Sunnybrook, Ann monitors and studies the actions, reactions, and interactions of drugs and the human body, which is also made of chemicals, and all react with each other in normal or abnormal ways, depending on the health of the patient.

Even though the chemistry of the human body is relatively constant around the world (some blood types are more prevalent in certain areas of the world, sickle-cell anemia is more common in tropical climates, and simple things like hydration levels differ from place to place), laws regulating drugs change from country to country, and, within Canada, from province to province. This requires a pharmacist to learn constantly, as new drugs with new effects and interactions come on the market. Ann attends conferences, works on task forces, reads as many journals as she can find time for, and generally works hard keeping up-to-date with the effects and benefits of all the latest drugs.

Making Connections

1. The pharmacy program in many universities is a "second-level entry program," which means that you must complete a year of university before applying. Find out what courses would be necessary in your first year of university to gain admission to a pharmacy program.

Work the Web

Chemicals (drugs or medicines) that react to each other or to certain medical conditions in a harmful way are called "contraindicated." Aspirin (acetylsalicylic acid), for example, is contraindicated for hemophiliacs. Visit www.science.nelson.com and follow the links from Science 10, 6.15 to find some contraindicated medicines. Report on two contraindicated situations.

Chapter 6 Summary

Key Expectations

Throughout the chapter, you have had opportunities to do the following things:

- Use the Law of Conservation of Mass as a rationale for balancing equations. (6.1, 6.2, 6.3, 6.4, 6.5)
- Represent chemical reactions using models, word equations, and balanced chemical equations. (6.1, 6.5, 6.7, 6.9, 6.10, 6.11, 6.12)
- Use appropriate apparatus and apply WHMIS safety procedures for handling, storage, disposal, and recycling of materials in the lab. (6.2, 6.4, 6.8, 6.9, 6.11, 6.12, 6.13)
- Formulate questions about practical problems and issues involving chemical processes. (6.2, 6.4, 6.8, 6.9, 6.11, 6.12, 6.14)
- Analyze data and information, evaluate evidence and sources of information, and identify errors and bias. (6.2, 6.4, 6.13, 6.14)
- Describe experimental procedures in the form of a laboratory report. (6.2, 6.4, 6.8, 6.9, 6.11, 6.12)
- Use appropriate vocabulary, SI units, tables, and descriptions of procedures using the scientific method. (6.2, 6.4)
- Compare theoretical and empirical values, and account for discrepancies in conservation of mass experiments. (6.2, 6.4)
- Describe from observations the reactants and products of a variety of chemical reactions, including synthesis, decomposition, and displacement reactions. (6.6, 6.7, 6.8, 6.9, 6.10, 6.11, 6.12, 6.13)
- Describe how an understanding of chemical reactions has led to new consumer products and technological processes. (6.6)
- Conduct chemical tests to identify common gases. (6.9, 6.11)
- Select and integrate information from many sources including electronic, print, and community resources, and personally collected data. (6.14)
- Explain how environmental challenges can be addressed through an understanding of chemical substances. (6.14)
- Explore careers based on technologies that use chemical reactions. (6.15)

Key Terms

balanced chemical equation
coefficient
combination reaction
combustion
decomposition reaction
double displacement reaction
hydrate
incomplete combustion
Law of Conservation of Mass
scientific law
single displacement reaction
skeleton equation
synthesis reaction
word equation

Make a Summary

(Y) Use a "fishbone" graphic organizer to summarize what you have learned in this chapter (**Figure 1**).

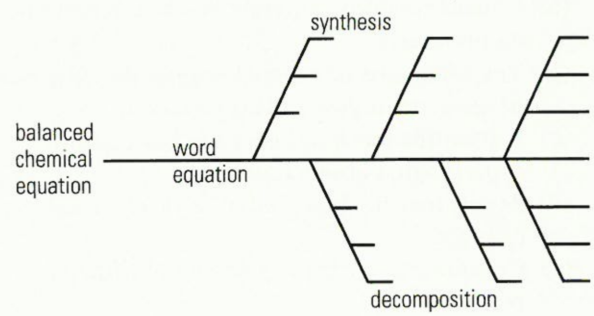

Figure 1

Reflect on your Learning

Revisit your answers to the Reflect on your Learning questions, page 217, in the Getting Started.

- How has your thinking changed?
- What new questions do you have?

SKILLS HANDBOOK: (Y) Graphic Organizers

Chapter 6 Review

Understanding Concepts

1. (a) State the Law of Conservation of Mass.
   (b) How does this law explain why we balance chemical equations?

2. For each of the following, replace the description with one or two words:
   (a) a reaction that involves the combination of two elements;
   (b) a solid compound that contains water molecules;
   (c) an unbalanced equation that describes formulas of substances;
   (d) the breaking apart of a larger molecule into smaller molecules;
   (e) the number placed in front of a formula in a balanced equation.

3. The sentences below contain errors or are incomplete. Write complete, correct versions.
   (a) A word equation contains words to represent compounds.
   (b) The total mass of products equals the total mass of reactants unless a gas is produced.
   (c) A scientific law is a theory used to explain experimental observations.
   (d) Atoms may be destroyed in some chemical changes.
   (e) Compounds are broken down in synthesis reactions.
   (f) Elements and compounds react in double displacement reactions.
   (g) Elements combine in single displacement reactions.
   (h) The products of the combustion of a hydrocarbon are carbon dioxide and oxygen.

4. Write word equations to represent the following changes and identify each of them as a synthesis, decomposition, single displacement, double displacement, or combustion reaction:
   (a) A welder's torch combines acetylene and oxygen gases to form carbon dioxide and water.
   (b) A piece of zinc metal added to silver nitrate produces zinc nitrate and silver.
   (c) When zinc carbonate is heated, zinc oxide and carbon dioxide are produced.
   (d) Nitrogen and oxygen gases react in automobile engines to produce poisonous nitrogen dioxide.
   (e) Potassium hydroxide and phosphoric acid react to produce water and potassium phosphate.
   (f) Hydrogen and nitrogen gases react to make ammonia used in fertilizer.

5. Determine whether the following equations are balanced as written. Balance the equation if necessary.
   (a) $CO + O_2 \rightarrow CO_2$
   (b) $Cl_2 + KBr \rightarrow Br_2 + KCl$
   (c) $4NH_3 + 3O_2 \rightarrow 2N_2 + 6H_2O$

6. Balance the following equations.
   (a) $Ca + HBr \rightarrow CaBr_2 + H_2$
   (b) $Al + O_2 \rightarrow Al_2O_3$
   (c) $KNO_3 + HBr \rightarrow KBr + HNO_3$
   (d) $Ba + H_3PO_4 \rightarrow Ba_3(PO_4)_2 + H_2$
   (e) $CaCl_2 + Al_2(SO_4)_3 \rightarrow CaSO_4 + AlCl_3$
   (f) $C_3H_8 + O_2 \rightarrow CO_2 + H_2O$

7. Write the corresponding word or skeleton equations and balanced chemical questions for each of the following.
   (a) $BaCl_2$ and Na_2SO_4 react to form $BaSO_4$ and NaCl.
   (b) When sulfuric acid and sodium hydroxide react, the products are sodium sulfate and the most important liquid on earth.
   (c) Potassium chlorate produces potassium chloride and a gas that causes a glowing splint to burst into flame.

8. You may have noticed that a silver utensil will tarnish or turn black over time (**Figure 1**).

Figure 1

   (a) What do you think the mass of the tarnished fork is compared to its original silver condition? Explain.
   (b) What do you think happens to the mass of the fork when the black tarnish is removed with a silver cleaner?

9. In an experiment, 24 g of magnesium react with 73 g of hydrogen chloride to produce a gas and 95 g of magnesium chloride.
   (a) Do these results prove the Law of Conservation of Mass? Explain your answer.
   (b) What gas do you think was produced? How much of the gas do you think was produced?

10. When methane (CH_4) burns in oxygen gas (O_2), it produces water (H_2O) and carbon dioxide (CO_2).
   (a) Write a skeleton equation for the reaction.
   (b) Draw a sketch to represent each of the molecules. For example, methane might be a black circle (carbon atom) attached to four white circles (hydrogen atoms).
   (c) According to the Law of Conservation of Mass, what relationship is there between the numbers of atoms in reactants and products?
   (d) Draw sketches to represent the numbers of molecules of each type necessary to balance the equation.
   (e) Write the balanced chemical equation for the reaction.

Applying Inquiry Skills

11. When baking soda and vinegar are mixed together, a chemical reaction occurs that produces carbon dioxide gas. Baking soda is $Na(HCO_3)$ and vinegar is a solution of acetic acid $H(C_2H_3O_2)$. (The brackets have been included here only to assist you.)
   (a) What kind of reaction involves two compounds as reactants?
   (b) Write a skeleton equation to represent the reactants and possible products.
   (c) One of the products is a soluble sodium compound and the other is an acid which can undergo a second reaction that produces water and a gas. Write a balanced chemical equation for this second reaction.

12. A student performs a reaction in which a metal is added to an acid solution and a gas is produced. The following results are obtained:
   mass of magnesium = 3.4 g
   mass of acid = 102.5 g
   mass of product solution = 105.6 g
   Calculate the mass of the gas produced.

13. Design an experiment to confirm the Law of Conservation of Mass. Check your design with your teacher before proceeding. Report on your findings.

14. When a car burns gasoline, it produces carbon dioxide and water vapour. Assuming that gasoline is octane, the skeleton equation for this reaction is
   $$C_8H_{18} + O_2 \rightarrow CO_2 + H_2O$$
   (a) What type of reaction is this?
   (b) Write a balanced equation for this reaction.
   (c) When a car burns one litre of gasoline, it produces about 2.5 kg of carbon dioxide. Make a rough calculation of the number of litres of gasoline that your family car burns in an average week. How many kilograms of carbon dioxide are produced at the same time?
   (d) Why is carbon dioxide an environmental concern?
   (e) What steps do you think people should take to deal with this environmental issue?

Making Connections

15. An important industrial process is the refining of iron ore in a blast furnace (**Figure 2**). In the reaction, carbon displaces iron metal from impure iron(III) oxide. The word and skeleton equations for this reaction are
   carbon + iron(III) oxide → iron + carbon dioxide
   $$C + Fe_2O_3 \rightarrow Fe + CO_2$$

Figure 2

   (a) Write a balanced chemical equation for this reaction.
   (b) What type of reaction is this?
   (c) What element displaces the iron?
   (d) What type of element is carbon?
   (e) How is this reaction different from the pattern of reactions that you learned about in this chapter?

16. Cyclopropane (C_3H_6) is a hydrocarbon that was once used as an anaesthetic. Its properties, however, made it a safety concern.
   (a) What type of chemical reaction could cyclopropane undergo?
   (b) Write word, skeleton, and balanced chemical equations for this reaction.
   (c) What types of safety precautions do you think medical personnel would have had to follow to prevent this reaction?

17. Survey newspaper articles about pollution and/or industrial processes for a week. Build a scrapbook of articles that support a pro-industry or a pro-environmental viewpoint. Analyze the point of view of the newspaper. Which point of view does it seem to support, either in editorials, in amount of coverage, or in the tone of the articles?

CHAPTER

7 Controlling Chemical Reactions

Getting Started

WHY ARE SOME REACTIONS MUCH FASTER THAN OTHERS?
When a hiker lights a campfire, the wood reacts quickly in air to produce heat and light, and carbon dioxide and water vapour. You have learned that this process is called combustion. Other substances react with air or oxygen in chemical processes that are much slower. For example, the rusting of a steel garden tool is a slow reaction of iron with oxygen.