

The Impact of Petroleum Products

14.5

Products made from petrochemicals (which are obtained from petroleum and natural gas) have profoundly influenced your life. Because of petrochemicals, you can use numerous products that did not exist 50 years ago (See Figures 14.26, 14.27, and 14.28). For example, one of the most common materials around you—plastic—is made from petrochemicals. The large numbers of petrochemicals that are used in manufacturing, however, are insignificant when compared with the vast quantities of hydrocarbons that are consumed each year as fossil fuels. As you learned in Chapter 13, almost 95% of all petroleum that is extracted from the ground is used as fuels and lubricants for vehicles.

Is there a cost for all that we obtain from hydrocarbons? Do these amazing products carry any drawbacks? In this section, you will examine some pros and cons of our society's reliance on hydrocarbons. You will begin to assess the benefits and the risks of materials that you take for granted and use every day.

Section Preview/ Specific Expectations

In this section, you will

- **assess** some risks and benefits of hydrocarbon use in our society
- **communicate** your understanding of the following terms: *risk, benefit, risk-benefit analysis, greenhouse gases, global warming, sustainable development*



Figure 14.27 Polystyrene foam insulation, such as Styrofoam™, prevents heat flow and does not absorb water.



Figure 14.26 Materials such as Gore-Tex® fabric (made from a polymer of ethene) are important in the outdoor activities industry.



Figure 14.28 Artificial hip joints allow people who are disabled by arthritis to walk again.



CHECKPOINT

Hydrocarbons, such as fossil fuels, carry both risks and benefits. In a group, brainstorm to identify some risks and benefits.



Figure 14.29 Would you like to have a coal-burning power plant near your home? Some people might be upset by this idea because there is a health risk caused by pollution from the plant. Other people might think that a coal-burning power plant poses no threat at all. Who is right? How do you decide?

Risks and Benefits

A **risk** is a chance of possible negative or dangerous results. Riding a bicycle carries the risk of falling off. Driving a car carries the risk of an accident. Almost everything you do has some kind of risk attached. Fortunately most risks are relatively small, and they may never happen. Many of the activities that carry risks also carry benefits. A **benefit** is an advantage, or positive result. For example, riding a bicycle provides the benefits of exercise, transportation, and enjoyment. When deciding to do an activity, it may be a good idea to compare the risks and benefits involved. (See Figure 14.29.)

Risk-Benefit Analysis

Knowing more about an issue helps you assess its risks and benefits more accurately. How can you make the most informed decision possible? Follow these steps to do your own assessment of risks and benefits, called a **risk-benefit analysis**.

- Step 1** Identify possible risks and benefits of the activity. Decide how to research these risks and benefits.
- Step 2** Research the risks and benefits. You need information from reliable sources to make an accurate analysis.
- Step 3** Weigh the effects of the risks and benefits. You may find that the risks are too great and decide not to do the activity. On the other hand, you may find that the benefits are greater than the risks.
- Step 4** Compare your method for doing the activity with other possible methods. Do you use the safest method to do the activity? One method may be much safer than another.

In the next Sample Problem, you will see how a risk-benefit analysis can help you make informed decisions.

Sample Problem

Smoking

Problem

Many of your friends smoke, including some people you respect. Lately you have been thinking about taking up smoking too. Should you smoke? Perform a risk-benefit analysis to help you decide.

What Is Required?

You need to perform a risk-benefit analysis of smoking. This includes identifying, researching, and weighing the risks and benefits of smoking. It also includes looking at different methods of smoking, which might reduce the risk.

What Is Given?

The problem mentions that many of your friends smoke. This indicates a possible benefit of smoking—you will be imitating people

Continued ...

you like and respect. You need to do some research to identify more benefits and risks.

Plan Your Strategy

Use these four steps to identify and assess the risks and benefits of smoking.

Step 1 Identify possible risks and benefits.

Step 2 Research the risks and benefits. Use the Internet, reference books such as encyclopedias, and other sources to help you. It is important to choose reliable sources from which to obtain information.

Step 3 Weigh the risks and benefits.

Step 4 Compare different methods of smoking. Is one method less risky than another?

Act on Your Strategy

Step 1 Identify possible risks and benefits.

Possible risks	Possible benefits
Smoking is hazardous to your health.	Your friends smoke.
	Smoking may help you relax.

At this point, the benefits appear to outweigh the risks. You need to do more research, however, to make an informed decision.

Step 2 Research the risks and benefits.

Further research on the Internet provides more information on smoking risks:

Risks	Benefits
The tobacco smoke inhaled when smoking contains many toxic substances, such as carbon monoxide and ammonia gas.	Your friends smoke.
Smoking is the number one cause of lung cancer, heart disease, and emphysema.	Smoking may help you relax.
Smoking is addictive.	
About 50% of smokers end up dying from a tobacco-related disease.	
Second-hand smoke harms the people around you.	

Step 3 Weigh the risks and benefits of smoking.

The risks of smoking heavily outweigh the benefits.

Step 4 Compare different methods of smoking. Is one method less risky?

Smoking only one cigarette a day is less risky than smoking a pack a day. You cannot count on this method, however. Any kind of smoking is risky.

Web

LINK

www.school.mcgrawhill.ca/resources

To access more information on solar panels, natural gas heating, and the environmental effects of burning fossil fuels, go to the web site above. Go to **Science Resources**, then to **Chemistry 11** to find out where to go next. Use this information to help you answer Practice Problem 26.

Practice Problems

25. Your town is considering dumping its plastic waste in a nearby lake. Identify possible risks and benefits for this plan. Explain where you could find more information to help your town make a decision.
26. Earth's reservoir of fossil fuels, including natural gas, will not last forever. As well, burning fossil fuels releases carbon dioxide (a greenhouse gas) and other pollutants that can cause acid rain. On the other hand, alternate energy sources, such as solar panels, are more expensive. They can also be less reliable than using fossil fuels. Perform a risk-benefit analysis to decide if you should heat your home using natural gas or solar panels. You will need to do more research to make an informed decision. (See the Internet Link on this page.)

Hydrocarbons: A Risky Business?

How do hydrocarbons benefit our society? How do they affect the environment? What are the benefits and risks of using hydrocarbon fuels and petrochemicals? These are important questions for our global community. See Figure 14.30 for some ideas.

Figure 14.30



Hydrocarbon fuels have changed the way we live. Our dependence on them, however, has affected the world around us. The greenhouse effect, global warming, acid rain, and pollution are familiar topics on the news today. Our use of petroleum products, such as oil and gasoline, is linked directly to these problems.

The Greenhouse Effect and Global Warming

Roads, expressways, service stations, and parking lots occupy almost 40% of Toronto. They are the result of our demand for fast and efficient transportation. Every day, Toronto's vehicles produce nearly 16 000 t of carbon dioxide by the combustion of fossil fuels. Carbon dioxide is an important greenhouse gas. **Greenhouse gases** trap heat in Earth's atmosphere and prevent the heat from escaping into outer space. Scientists think that a build-up of carbon dioxide in the atmosphere may lead to an increase in global temperature, known as **global warming**. The diagram below shows how these concepts are connected to fossil fuels.

Web

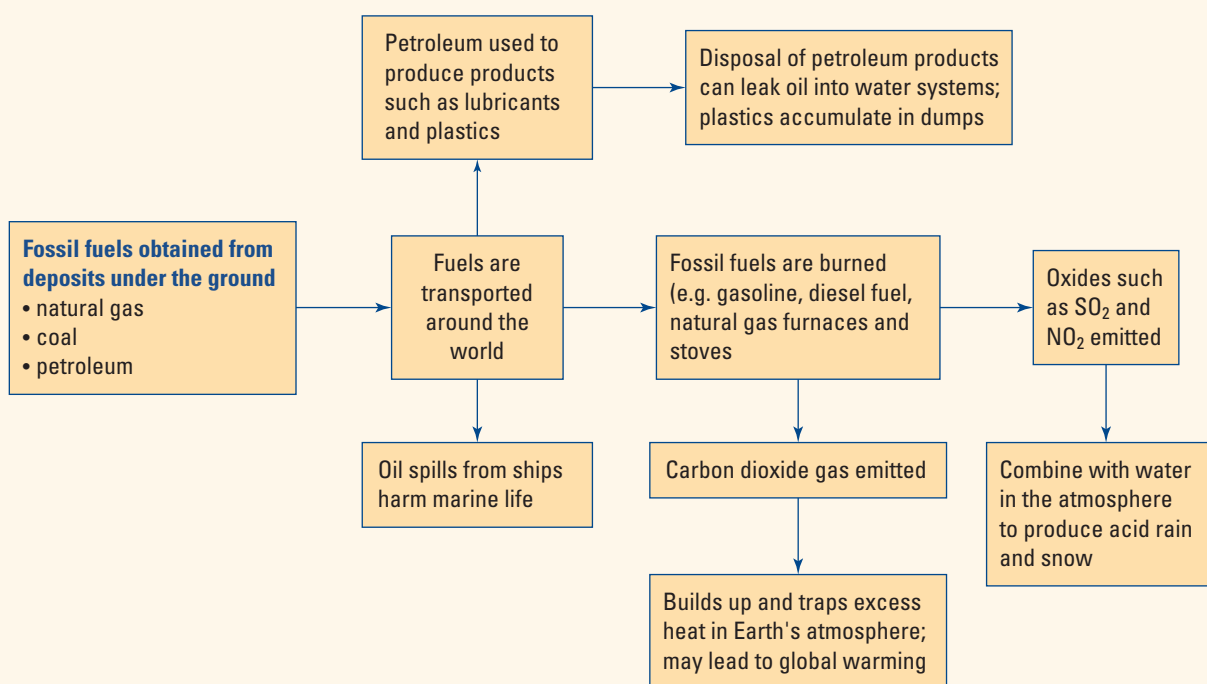
LINK

www.school.mcgrawhill.ca/resources/

To learn more about greenhouse gases, global warming, and acid rain, go to the web site above. Go to **Science Resources**, then to **Chemistry 11** to find out where to go next.

Concept Organizer

Hydrocarbons and the Environment



Acid Rain

The combustion of fossil fuels releases sulfur and nitrogen oxides. These oxides react with water vapour in the atmosphere to produce acid rain. Some lakes in northern Canada are “dead” because acid rain has killed the plants, algae, and fish that used to live in them. Forests in Québec and other parts of Canada have also suffered from acid rain.

Oil Spill Pollution

Our society demands a regular supply of fossil fuels. Petroleum is transported from oil-rich countries to the rest of the world. If an oil tanker carrying petroleum has an accident, the resulting oil spill can be disastrous to the environment.

Oil Spill Advisor

Developed nations, such as Canada, depend heavily on petroleum. Our dependence affects the environment in many ways. Oil spills are a dramatic example of environmental harm caused by petrochemicals. In the news, you may have seen oceans on fire and wildlife choked with tar. What can we do?



Obviously the best thing to do is to prevent oil spills from taking place. Stricter regulations and periodic inspections of oil storage companies help to prevent oil leakage. Once an oil spill has occurred, however, *biological*, *mechanical*, and *chemical* technologies can help to minimize harm to the environment.

Biological methods involve helpful micro-organisms that break down, or *biodegrade*, the excess oil. Mechanical methods depend on machines that physically separate spilled oil from the environment. For example, barriers and booms are used to contain an oil spill and prevent it from spreading. Materials such as sawdust are sprinkled on a spill to soak up the oil.

Two main chemical strategies are also used to clean up oil spills. In the first strategy, *gelling agents* are added to react with the oil. The reaction results in a bulky product that is easier to collect using mechanical methods. In the second strategy, *dispersing agents* break up oil into small droplets that mix with the water. This prevents the oil from reaching nearby shorelines. Dispersing agents work in much the same way as a bar of soap!

The scientific advisor for an oil spill response unit assesses a spill and determines the appropriate clean-up methods. She or he acts as part of a team of advisors. Most advisors have an M.Sc. or Ph.D. in an area of expertise such as organic chemistry, physical chemistry, environmental chemistry, biology, oceanography, computer modelling, or chemical engineering.

Oil spill response is handled by private and public organizations. All these organizations look for people with a background in chemistry. In fact, much of what you are learning about hydrocarbons can be related to oil spill response. Hydrocarbon chemistry can lead you directly to an important career, helping to protect the environment.

Make Career Connections

Create a technology scrapbook. Go through the business and employment sections in a newspaper. Cut out articles about clean-up technologies. What kinds of companies are doing this work? What can you learn about jobs in this field? What qualifications does a candidate need to apply for this type of job?

Web

LINK

www.school.mcgrawhill.ca/resources/

Go to the web site above to learn about the famous oil spill caused by the *Exxon Valdez*. Go to **Science Resources**, then to **Chemistry 11** to find out where to go next. When and where did this oil spill occur? How did it affect the environment? What was done to clean it up?

Everyday Oil Pollution

The biggest source of oil pollution comes from the everyday use of oil by ordinary people. Oil that is dumped into water in urban areas adds to oil pollution from ships and tankers. In total, *three million tonnes* of oil reach the ocean each year. This is equivalent to having an oil spill disaster every day!

A student from Thornhill, Ontario, did a home experiment to discover how much oil remains in “empty” motor oil containers that are thrown out. He collected 100 empty oil containers from a local gas station. Then he measured the amount of oil that was left in each container. He found an average of 36 mL per container. Over 130 million oil containers are sold and thrown out in Canada each year. Using these figures, he

calculated that nearly five million litres of oil are dumped into landfill sites every year, just in “empty” oil containers!

Once oil reaches the environment, it is almost impossible to clean up. Oil leaking from a landfill site can contaminate drinking water in the area. Because oil can dissolve similar substances, pollutants such as chlorine and pesticides, and other organic toxins, mix with the oil. They are carried with it into the water system, increasing the problem.

Solutions to Environmental Problems

All of the problems described above hinge on our use of fossil fuels. Thus, cutting back on our use of fossil fuels will help to reduce environmental damage. Cutting back on fossil fuels, however, depends on the consumers who buy petrochemicals and use fossil fuels. In other words, it depends on you and the people you know.

Corporations that are looking for profit have little incentive to change their use of fossil fuels. For example, the technology is available to build cars that can drive about 32 km on a single litre of fuel. Because this technology is not financially profitable, cars are still being produced that drive about 8 km per litre of fuel. If consumers demand and purchase more fuel-efficient cars, however, car manufacturers will have an incentive to produce such cars. Tougher government standards may also help to push the vehicle industry towards greater fuel efficiency.

Governments can also bring about change by endorsing the principle of sustainable development. This principle was introduced at the 1992 Earth Summit Conference. **Sustainable development** takes into account *the environment, the economy, and the health and needs of society*. (See Figure 14.31.)

Hydrocarbon fuels and products can benefit our society if they are managed well. They can cause great environmental damage, however, if they are managed irresponsibly. With enough knowledge, you can learn to make informed decisions on these important issues. Here are some suggestions of ways you can reduce your consumption of petroleum products. Why not choose one or more methods to practice? Or, brainstorm with your classmates to think of other ways to reduce consumption.

- Contact your local government and local power companies. Suggest using alternative fuels, such as solar energy and wind power.
- Ride a bicycle or walk more.
- Express your concerns by writing letters to the government or to newspapers.
- Become more informed by researching issues that concern you.
- Fix oil leaks in vehicles, and avoid dumping oil down the sink.
- If you are cold at home, put on an extra sweater instead of turning up the heat.
- Recycle and re-use petrochemical products, such as plastic shopping bags.
- Repair a broken item rather than buying a new one.

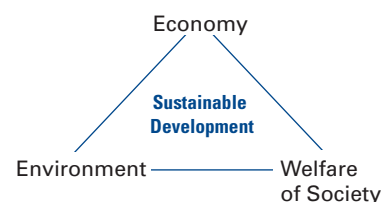


Figure 14.31 Canada and other members of the United Nations endorse the principle of sustainable development. This principle states that the world must find ways to meet our current needs, without compromising the needs of future generations.

Section Wrap-up

In this section, you learned about some of the risks and benefits resulting from our use of fossil fuels. We obtain gasoline, heating oil, jet fuel, diesel fuel, fertilizers, and plastics from the oil and petroleum industry. Burning fossil fuels, however, produces carbon dioxide (a greenhouse gas) and other pollutants that lead to acid rain. Transporting oil also carries the risk of oil spills. Do the benefits of fossil fuels outweigh the risks? Complete these Section Review questions to help you decide.

Section Review

- 1 **K/U** You are about to try water-skiing for the first time. Should you try it? Will your activity affect the environment? How will you make your decision?
 - (a) Describe the steps you would follow to do a risk-benefit analysis.
 - (b) What are some possible risks and benefits?
 - (c) Where might you find the information you need to make a decision?
- 2 **C** Identify three benefits and three risks associated with the use of petroleum products and petrochemicals.
- 3 **C** Identify some steps that you can take to reduce your dependence on petroleum.
- 4 **MC** A construction company is planning to level a forest near your home to build a strip mall with a large parking lot. Many people enjoy walking in the forest, and many children play there. You have also observed wildlife, such as rabbits, snakes, frogs, and many kinds of birds living in the forest. In a group, brainstorm ways that the company could consider the environment and human welfare, as well as the economy. (Think of the economy as the owner of the property and the stores that will be built.)
- 5 **MC** Perform a risk-benefit analysis of the petroleum industry. Use the information in this section to help you identify possible risks and benefits. Use the Internet, or reference books to do more research on these risks and benefits.
- 6 **MC** Impure coal and gasoline contain nitrogen and sulfur compounds ($\text{NO}_{(\text{g})}$ and $\text{S}_{(\text{s})}$). The combustion of nitrogen and sulfur produces oxides that lead to acid rain.
 - (a) Balance the following six equations.
$$\text{S}_{8(\text{s})} + \text{O}_{2(\text{g})} \rightarrow \text{SO}_{2(\text{g})}$$
$$\text{S}_{8(\text{s})} + \text{O}_{2(\text{g})} \rightarrow \text{SO}_{3(\text{g})}$$
$$\text{NO}_{(\text{g})} + \text{O}_{2(\text{g})} \rightarrow \text{NO}_{2(\text{g})}$$
$$\text{SO}_{2(\text{g})} + \text{H}_2\text{O}_{(\ell)} \rightarrow \text{H}_2\text{SO}_{3(\text{aq})}$$
$$\text{SO}_{3(\text{g})} + \text{H}_2\text{O}_{(\ell)} \rightarrow \text{H}_2\text{SO}_{4(\text{aq})}$$
$$\text{NO}_{2(\text{g})} + \text{H}_2\text{O}_{(\ell)} \rightarrow \text{HNO}_{3(\text{aq})} + \text{HNO}_{2(\text{aq})}$$
 - (b) Suggest possible sources for the reactants $\text{O}_{2(\text{g})}$ and $\text{H}_2\text{O}_{(\ell)}$.
 - (c) Explain how these equations show the production of acid rain.