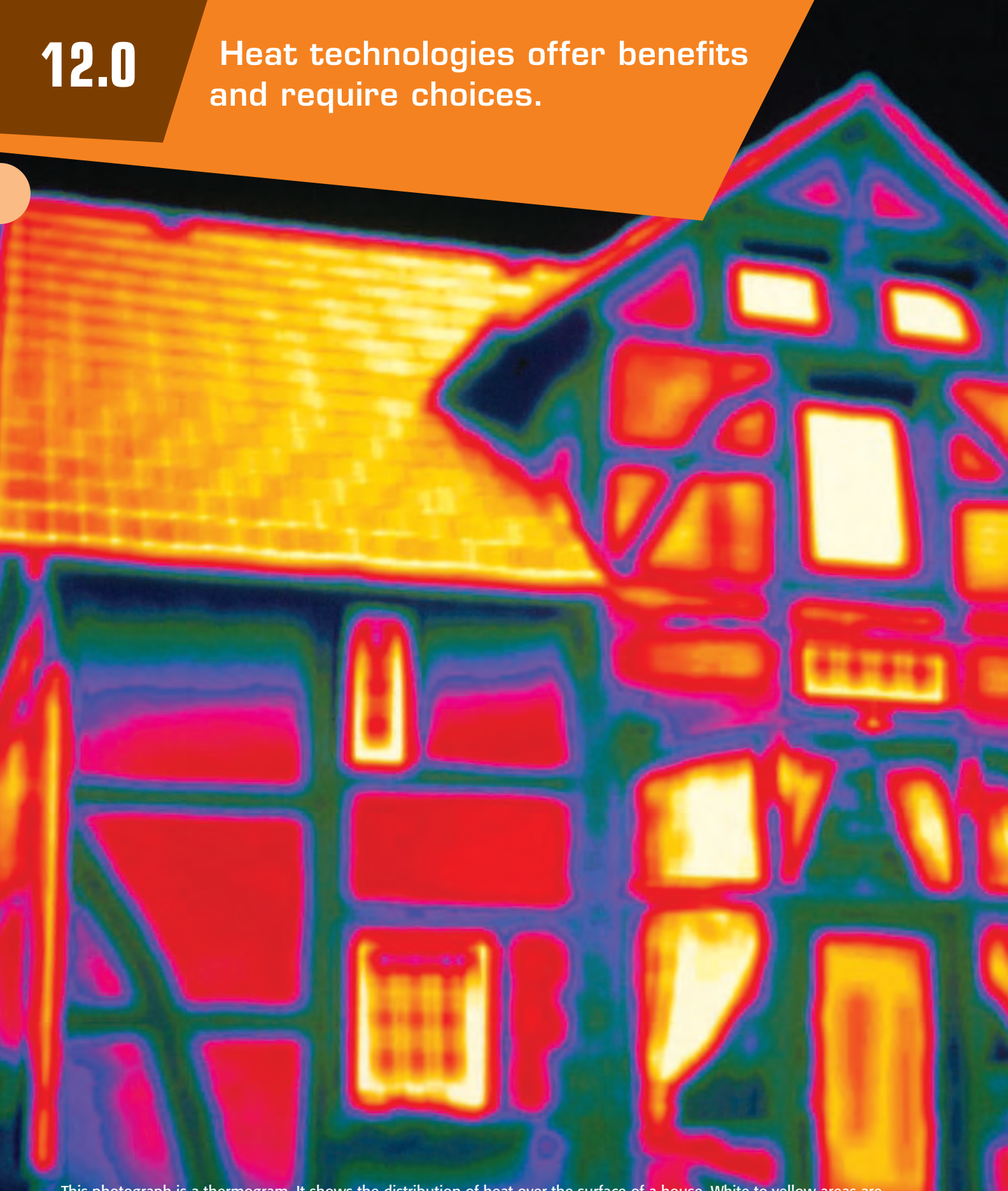
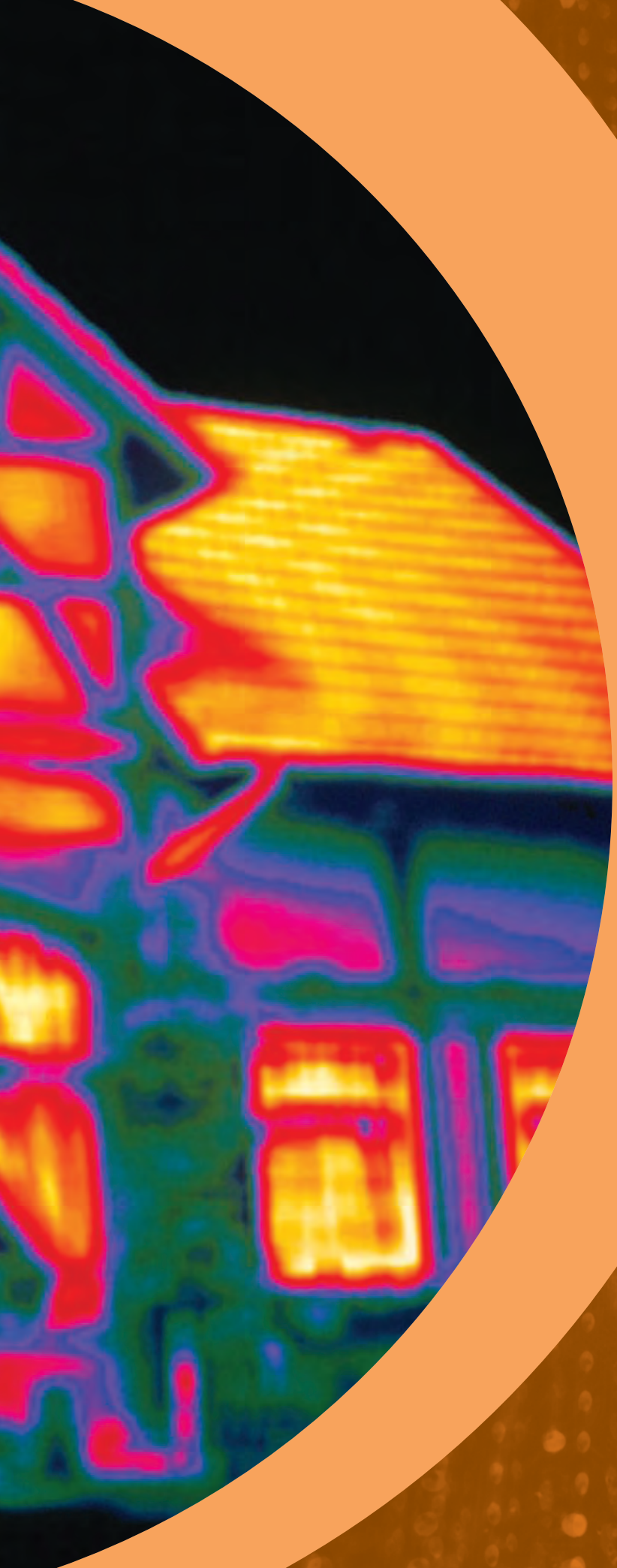
# 12.0 Heat technologies offer benefits and require choices.



This photograph is a thermogram. It shows the distribution of heat over the surface of a house. White to yellow areas are warmest. Red to purple and green are coolest. The thermogram shows that the roof and windows of the house are poorly insulated, while the better-insulated walls lose less heat to the environment.



## What You Will Learn

In this chapter, you will:

- demonstrate energy transformations that involve heat
- determine how you can reduce your use of energy
- discuss ways to decrease global warming

## Skills You Will Use

In this chapter, you will:

- use scientific inquiry/experimentation skills to investigate heat transfer
- use a variety of ways to communicate with audiences

## Why This Is Important

Heat has both positive and negative effects on the environment. Each of us has an important role to play in protecting the global environment. Canadians should be able to understand how technology can reduce heat loss. By reducing energy use, we make fewer negative changes in the world.

## Before Writing

Thinking Literacy

### Cause and Effect Pattern

Writers of non-fiction text use a variety of patterns to provide a structure for expressing their ideas clearly. Cause and effect pattern is one way to organize information. Think about what you know about cause and effect and look through this chapter for headings that might fit with this pattern. What other subject texts use this pattern for writing?

### Key Terms

- energy converter
- heat island
- global warming
- heat pollution
- greenhouse gases
- climate change

# 12.0 Getting Started

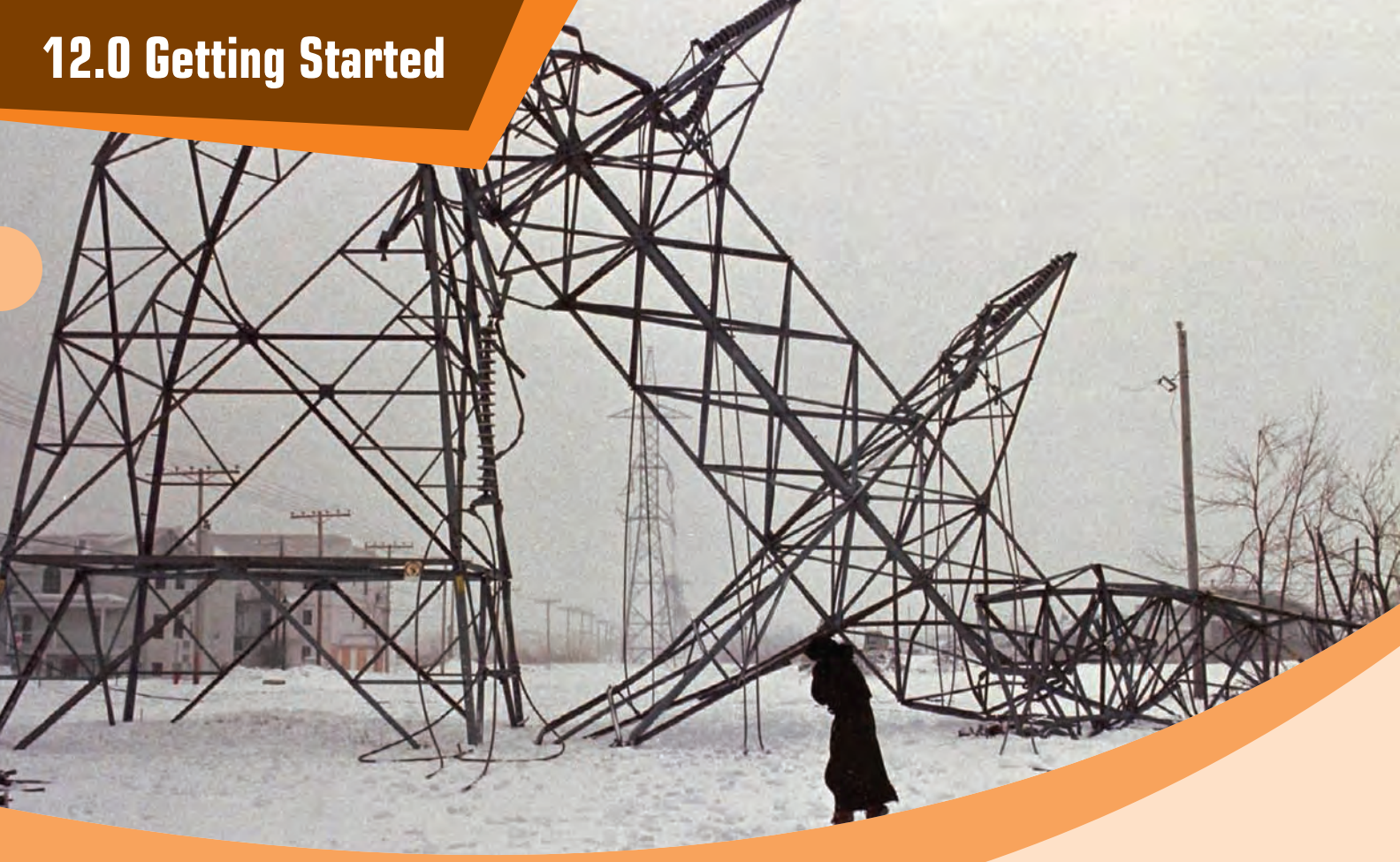


**Figure 12.1** These electrical transmission towers, and hundreds of others, were destroyed in the ice storm in 1998.

Ice storms are a common experience in most parts of Canada. They are especially common from Ontario to Newfoundland. The danger that an ice storm presents depends on the amount of ice that builds up and how long the storm lasts. The ice storm that lasted for five days in January 1998 was the worst ever recorded in Canada. From January 5 to 10, freezing rain, ice pellets, and a bit of snow fell — 85 mm in Ottawa, 73 mm in Kingston, 108 mm in Cornwall, and 100 mm in Montreal.

Without question, the storm directly affected more people than any previous weather event in Canadian history. The damage in eastern Ontario and southern Quebec was so severe that major rebuilding, not repairing, of the electrical system had to be undertaken (Figures 12.1 and 12.2). What it took human beings half a century to construct took nature a matter of hours to knock down.

**Figure 12.2** The ice storm also caused problems for people living in big cities.

Farmers were especially hard hit. Dairy and hog farmers were left without electricity needed to keep animal shelters warm and to run milking machines. Many Quebec maple syrup producers lost the entire supply of their sugar bush.

What caused such a severe storm? Canadian scientists think that a worldwide weather pattern called El Niño may have played a role in the ice storm of 1998.

Winter disasters such as the ice storm disrupt the delivery of energy that we use to heat our homes and places of work. This use of heat is very important for daily life, business, and industry. Being prepared for such disasters is therefore an important part of life in Canada.

## D39 *Quick Lab*

### Keep Your Cool

If it's not protected from warmer temperatures, ice will melt quickly. There are different ways to prevent melting.

#### Purpose

To compare ways of preventing ice from melting

#### Materials & Equipment

- 10 ice cubes
- plastic cooler
- tote cooler
- newspaper
- paper towel
- towel
- triple-beam balance or kitchen scale

**Figure 12.3** These pictures offer four ways to protect ice from the heat of the Sun and the air.

#### Procedure

1. Divide the class into five groups to test four possible ways to prevent melting of ice cubes.
   A: a plastic cooler  B: a tote cooler
   C: a towel  D: three sheets of newspaper
   E: no protection for the ice cubes
2. In groups, find mass #1 of two ice cubes, using the triple-beam balance or a kitchen scale. Record the mass.
3. Depending on your group letter, place the ice cubes in a cooler, or wrap them in the towel or the sheets of newspaper, or leave them sitting on paper towel.
4. Wait 30–45 min. Then dry the ice cubes with the paper towel.
5. Find mass #2 of the ice cubes using the triple-beam balance or scale.
6. Calculate the percent of ice remaining, using the following formula.

$$\%\ \text{ice remaining} = \left( \frac{\text{mass \#2 (g)}}{\text{mass \#1 (g)}} \right) \times 100\%$$

#### Questions

7. Which method was most effective in preventing the ice from melting?
8. How was heat transferred in this experiment?

# 12.1 Energy Transformations and Heat Pollution

**Here is a summary of what you will learn in this section:**

- Heat is often released to the environment when energy is transformed.
- Producing energy can release heat and gases into the environment.
- Heat pollution of land, water, and the atmosphere affects the environment.

**Figure 12.4** Sometimes energy conversions, like those in this vehicle, produce a lot of heat that is released into the environment.

Any device that transforms energy from one form to another is called an **energy converter**. The engine in your family car, a hair dryer, a computer hard drive, and a light bulb are all examples of energy converters (Figure 12.4). Energy converters can be much larger than these items. For example, the power plant that produces energy for your region is a very large energy converter.

Depending on where you live in Ontario, your community may obtain its electrical energy mainly from a thermal power plant that burns a fuel, such as coal or natural gas; a nuclear power plant that uses the energy stored in atoms; or a hydroelectric power plant that uses the energy of falling water.

## D40 *Starting Point*

Skills A C

### Go with the Flow

Since the 1970s, Canadians have been paying close attention to the energy we use (Figure 12.5). In 1973, the Organization of Petroleum Exporting Countries (OPEC) dramatically raised the price of oil by cutting back production. This caused the price of gasoline to jump in a few weeks from about 9 cents per litre to about 13 cents per litre. Compare that with today's prices and you will see that energy costs a lot more today! Starting at ScienceSource, collect and prepare a collage of images to illustrate the uses we have for fuels.

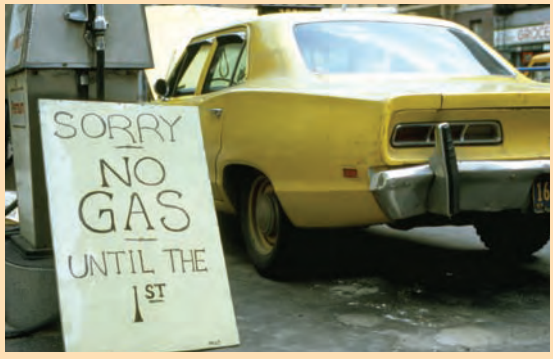



**Figure 12.5** In 1973, drivers of vehicles with odd-numbered licence plates could buy gasoline only on odd-numbered days of the month. Even-numbered licence plates were limited to even-numbered days.

## Hidden Costs of Power Plants

Each method of producing electricity has disadvantages. All of Ontario's power plants that burn coal may soon be closed or rebuilt to reduce air pollution and heat pollution (Figure 12.6). Nuclear power plants such as the Pickering, Darlington, and Bruce Nuclear Power Generating Stations use the energy stored in uranium atoms to produce electricity without air pollution (Figure 12.7). But there are other problems with nuclear energy. The disposal of heated waste water and how and where to store the nuclear waste that these plants produce are problems that need long-term solutions.

Ontario has more than three dozen hydroelectric generating stations. Hydroelectric power generation does not create air pollution (Figure 12.8). However, hydroelectric projects that include large dams may affect conditions in surrounding ecosystems. The hidden costs of power plants have led to the search for alternative sources of energy that have a less damaging impact on the environment.

**Figure 12.6** The Nanticoke coal-fired power plant on Lake Erie burns coal to produce electricity. It is Ontario's worst-polluting power plant.

**Figure 12.7** The Pickering Nuclear Power Generating Stations

**Figure 12.8** The Lac Seul Generating Station, a hydroelectric power plant in northwestern Ontario

**D41** *Learning Checkpoint*

### Energy Conversion

1. What is the purpose of an energy converter?
2. Name three energy converters that you or your family use regularly.
3. Name three kinds of power plants that produce electricity in Ontario.
4. Describe the method of energy production for each of the three types of power plant you suggested.

## Human Activities Produce Heat

You have learned that, in most energy transformations, the end result is the production of heat. A large quantity of heat may be produced, as in the engine of a car, or a small quantity, as in a student running a race. In all cases, the heat that is produced during an energy transformation is released into the environment.

Some human activities produce and release very large amounts of heat. This is particularly true in factories. Ontario manufacturers produce and ship hundreds of billions of dollars' worth of products every year. Most of this activity is found in the production of automobiles, metal, plastic and rubber products, computer products, chemical and petroleum products, machinery, and foods and beverages (Figure 12.9).


**Figure 12.9** Manufacturing products for human use produces a lot of heat. **(a)** An auto assembly line **(b)** The blast furnace in a steel plant **(c)** Crushed limestone stockpiled for use in iron ore smelting **(d)** A baked-goods assembly line

### Take It Further

Think about the different ways in which people produce energy to run our cities and farms. Then, use the Internet to gather information on the energy transformations that occur. Begin your search at ScienceSource.

## Adding Heat to the Atmosphere

Ontario has many factories. The easiest way to cool down a factory is to release hot air directly from the building into the environment. This is done by bringing fresh air into the building with large fans, circulating it, and sending the warm air back outside the building (Figure 12.10).

A second method is to use an air-conditioning system. This allows control over the indoor temperature. A third method for cooling buildings and machines is to circulate cool water from a water system such as a river. The cool circulating water absorbs the heat of the building. The hot water then circulates outside, releasing the stored heat into the air. Sometimes, the hot water is released into water systems, as in the nuclear power generating stations described earlier.

**Figure 12.10** Large fans such as these remove hot air from some buildings.

## Adding Heat to Natural Water Systems

Heat from human activities is added to the environment. If the release of heat has negative effects on an ecosystem, the added heat may be described as **heat pollution**. Living things are very sensitive to changes in temperature. Adding heat to a river or lake may cause a big problem for organisms that live in the water and cannot easily find another place to live.

Adding heat to a water system poses another problem. Organisms in water systems breathe oxygen, just like you do. Adding even a small amount of heat to a water system causes less oxygen to be available in the water for the organisms that depend on oxygen for survival. The result is that the organisms can suffer from a lack of oxygen and may die (Figure 12.11).

**Figure 12.11** Fish and other organisms die when there is not enough oxygen in a river or lake.

## D42 *Quick Lab*

### Heat Transfers Between Containers

#### Purpose

To measure and record changes in temperature between warmer and cooler liquids

#### Materials & Equipment

- two 400-mL beakers or small containers
- pail or large container
- thermometer
- warm water and cool water

#### Procedure

1. Add warm water to the pail to a depth of several centimetres. Half-fill the beaker with cool water.
2. Draw a data table to record the temperature (every minute for 20 min) of the warm water in the pail and the cooler water in the beaker.
3. Predict how the temperature of the water in the pail and in the beaker will change over 20 min. Record your predictions.
4. Use the thermometer to measure the starting temperature of the water in each container. Record your results in your data table.
5. Use the second beaker to add cool water to the pail and warm water to the beaker.
6. Measure and record the temperature in each container every minute for 20 min.
7. Draw and label a graph to show the change in temperature of the water in the pail. Colour your line. On the same graph paper, use a different colour to draw a graph to show the change in temperature of the water in the beaker. Include a legend and a title.

#### Questions

8. What happened to the thermal energy of the warm water added to the beaker?
9. Describe what happened to the temperature of the water in the pail.

# 12.1 CHECK and REFLECT

## Key Concept Review

1. What happens to the heat that is produced during an energy transformation?
2. Name two or more ways in which buildings can be cooled.

3. What are two of the disadvantages of using coal as a fuel in power plants that produce electricity in Ontario?

## Connect Your Understanding

4. How does a hair dryer act as an energy converter?
5. Name several energy transformations that release heat into the environment.
6. Describe two ways in which adding heat to water systems can be harmful to fish and other organisms that live in the water.
7. Why do you think Canadians have become concerned about gases and heat that are released into the environment every day?

## Practise Your Skills

8. Draw a Venn diagram to compare and contrast the kind of fuel used and the kind of energy released by the three plants shown in Figures 12.6, 12.7, and 12.8 on page 347.

For more questions, go to ScienceSource.

## D43 *Thinking about Science and the Environment*

### Extra Energy

You have learned that human activities produce heat that ends up in the environment. This release of heat can affect living things.

Canada's population increases every year. How might this increase affect the amount of energy used and the amount of heat produced?

#### Consider This

With a classmate or as a whole class, discuss the following questions.

1. In what ways can Canadians reduce their personal use of energy?
2. How can individual Canadians and communities be encouraged to use less energy? Suggest several ways.

# 12.2 Heat, Gases, and the Atmosphere

**Here is a summary of what you will learn in this section:**

- Heat islands influence local weather conditions.
- Human activities release gases that might contribute to global warming.
- Climate changes are occurring in the environment.

Hot summer days can be a big problem for some city dwellers. In North America, more than 1000 people die each year due to high environmental temperatures. Many more are rushed to hospitals, suffering from heat-related illness.

Each year, the Toronto Public Health Department issues Heat Alerts and Extreme Heat Alerts. For example, in 2007, from May through August, 15 of these alerts were issued. To prepare for and respond to these serious situations, Toronto has developed the Hot Weather Response Program.

**Figure 12.12** Help in the heat

## D44 *Starting Point*

Skills A C

### Heat Islands

In large cities, human activity can add a significant amount of heat to the environment. However, the way a city is built also has a big influence on the temperatures in and around it.

Look at Figure 12.13. Compare the rural areas, suburbs, and parks with the downtown areas. Suggest three or more reasons for the temperature differences that you observe.

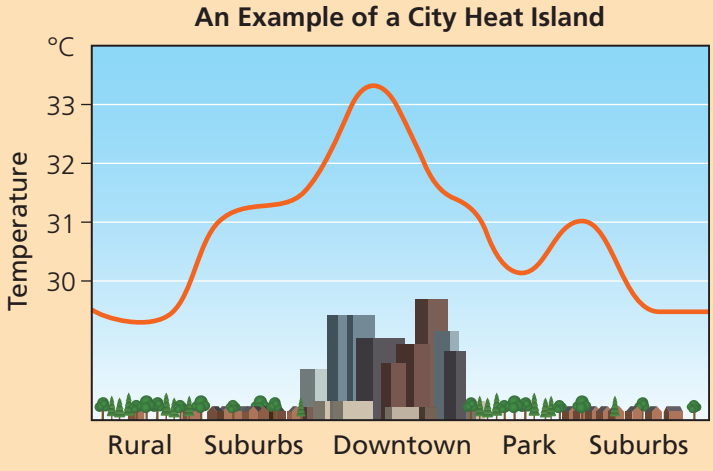



**Figure 12.13** This graph shows how a typical city is warmer than the surrounding areas. Air temperatures are usually measured about 1.5 m above the ground.

## Heat Islands

A **heat island** is a region of a city that has higher air and surface temperatures than its surroundings. The temperature difference is usually greater at night than in the day and greater in winter than in summer. It is most obvious when winds are weak.

Heat islands form as cities grow and replace natural land cover with buildings and pavement (roads and sidewalks). The increase in temperature in and above a heat island depends on an area's natural weather and climate, closeness to water bodies like lakes and oceans, and land forms like nearby mountains and valleys.

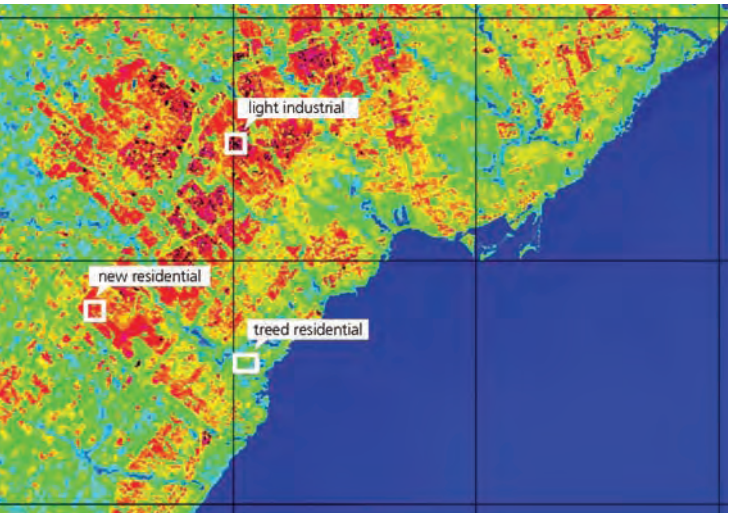



**Figure 12.14** A satellite infrared image of Toronto. Yellow and red colours indicate higher temperatures.

Climate scientists use infrared satellite photographs to measure the size of heat islands (Figure 12.14). This information allows city planners to prepare for heat emergencies during hot summers, to determine regulations for building sizes and heights, and to gauge how much parkland and green spaces a city needs.

Heat islands also affect the surrounding areas. For example, scientists have found that partly as a result of the heat island effect, monthly rainfall is about 28 percent greater in areas 10–20 km downwind of some cities compared with upwind. In the winter, some cities in cold climates may benefit from the warming effect of heat islands. In general, the harmful summertime effects from heat islands are greater than the wintertime benefits.

**D45** *During Writing*

Thinking Literacy

### Cause or Effect or Both?

Cause and effect writing gives reasons for why something happened or is happening. You have just read about heat islands. What features of cities cause heat islands to form and grow in size? Develop a simple graphic organizer to show the cause and effect relationship between heat islands and their causes.

Extend your thinking further. Can heat islands also be a cause for something else? In another organizer, show some of the effects of heat islands on local weather conditions. Reread the last paragraph on heat islands to find signal words the writer used. Can you think of other signal words a writer might use in cause and effect pattern?

# Monitoring Gases in the Atmosphere

Each time you breathe out, you release carbon dioxide and other gases. Each time your family drives you to school or a shopping centre, the family car releases carbon dioxide and other gases. One person, one family, and one automobile may not seem to be a problem. However, each of us adds many thousands of litres of carbon dioxide to the atmosphere every year. Millions of Canadians with millions of automobiles and billions of people on Earth add billions of litres of carbon dioxide to the atmosphere each year.

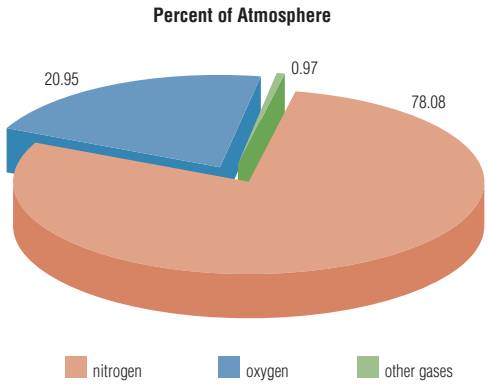



**Figure 12.15** The main components of the air we breathe

You might wonder if this large amount of additional carbon dioxide affects the planet. You would not be alone. Scientists in many countries are investigating this question.

Earth's atmosphere contains many gases, including nitrogen, oxygen, and argon. These three gases make up about 99 percent of the air we breathe (Figure 12.15). Carbon dioxide normally makes up only 0.037 percent of air. Because carbon dioxide is naturally present in air, it is not considered to be a pollutant. But the amount of carbon dioxide that humans are adding to air has become a concern for scientists, governments, and citizens in many countries, including Canada.

## What Is the Greenhouse Effect?

If you place a sealed glass container in sunlight or under a strong light, the air inside the container quickly becomes hot. This is like the inside of an automobile becoming hotter than the air outside on a cold, sunny day in winter (Figure 12.16). It is also like a greenhouse, where the glass sides and roof allow the Sun's radiation to enter, trapping the heat, warming the air, and helping plants to grow.

In some ways, our planet also acts like a greenhouse. Earth's atmosphere is like the glass sides and roof of the greenhouse or the glass windows of an automobile. The atmosphere allows radiation from the Sun to reach Earth's surface. Several of the gases in the atmosphere, like carbon dioxide, trap this heat, warming the land and oceans (Figure 12.17 on the next page).

**Figure 12.16** The air inside this automobile is much warmer than the air outside.

**Figure 12.17** The greenhouse effect. Some of the radiant energy from the Sun is trapped near Earth's surface by gases in the atmosphere that act like the glass in a greenhouse.

Some of the energy that reflects back into the atmosphere from the land and oceans also warms the air. Gases in the atmosphere that trap heat are called **greenhouse gases**. Water vapour, carbon dioxide, methane, and nitrogen oxides are all examples of greenhouse gases.

The **natural greenhouse effect** is the natural range of temperatures that Earth experiences because the greenhouse gases in the atmosphere trap energy from the Sun. Without these gases, heat would escape back into space and Earth's average temperature would be about 16°C colder.

## The Enhanced Greenhouse Effect

Human activities, such as burning non-renewable fuels like gasoline and coal release greenhouse gases into the atmosphere. Most scientists who study climate support the theory that these activities are contributing to an **enhanced greenhouse effect** (Figure 12.18). This effect is due to the build-up in the atmosphere of higher than normal amounts of greenhouse gases.

Table 12.1 shows some of the common sources of greenhouse gases, natural and related to human activity. It also shows some ways of reducing emissions of these gases.

### Take It Further

What is Canada doing to meet its commitments under climate change agreements such as the Kyoto Protocol? Begin your search at ScienceSource.

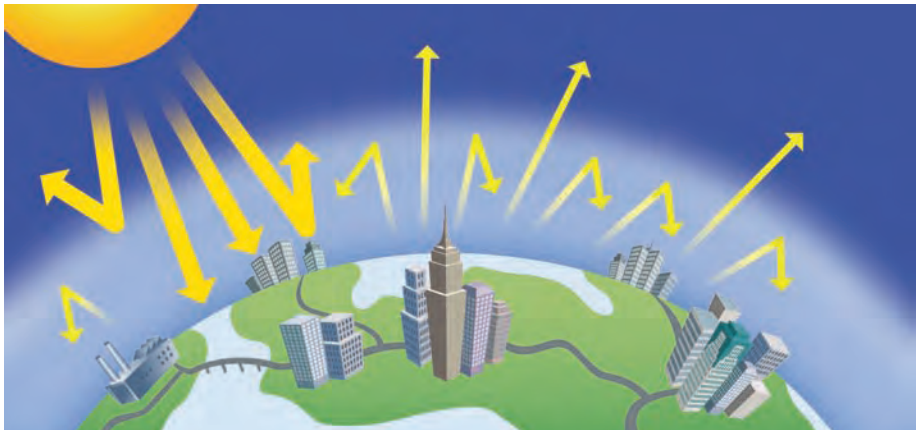


**Figure 12.18** The enhanced greenhouse effect: Human activities are adding more greenhouse gases to the atmosphere. Many scientists agree that this causes more heat to be trapped, causing Earth's temperature to rise. This is called global warming.

**Table 12.1** Greenhouse gases

| Greenhouse Gas | Common Ways the Gas Is Released into the Environment | Possible Ways to Reduce Emissions |
|---|---|---|
| Water vapour ($H_2O$) | • Through the water cycle | • Reduction of water vapour is not needed. |
| Carbon dioxide ($CO_2$) | • When humans and other animals breathe out<br>• When non-renewable fuels are burned in power plants and in vehicles | • Decrease use of non-renewable fuels, and increase alternative methods of energy production.<br>• Use alternative fuels to power vehicles. |
| Methane ($CH_4$) | • From natural sources: wetlands, termites<br>• When grazing animals digest food<br>• When non-renewable fuels are extracted from deep underground by drilling | • Decrease use of non-renewable fuels, and increase alternative methods of energy production.<br>• Develop ways to use natural methane. |
| Nitrogen oxides ($NO_x$) | • From natural sources in soils<br>• From fertilizers on farms<br>• When gasoline is burned in vehicles | • Use alternative fuels to power vehicles.<br>• Reduce fertilizer run-off. |

# Global Warming

Scientific data indicate that Earth's climate has become warmer over the past 150 years. This worldwide average increase in temperature of Earth's atmosphere, land, and oceans is called **global warming**. The warming has been increasing more quickly over the past 20 years. This change in the climate has become a concern for Canadians and for citizens in many countries.

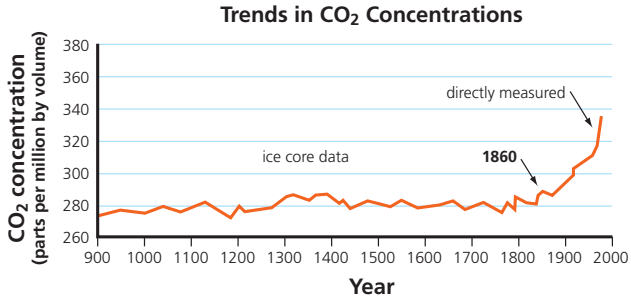



**Figure 12.19** Changes measured for carbon dioxide gas in Earth's atmosphere

Most scientists agree that the rise in average temperature is related mainly to increases in greenhouse gases in the atmosphere over the same period, since about 1860 (Figures 12.19 and 12.20). These scientists believe that we must quickly and significantly decrease or change human activities that release greenhouse gases or that prevent nature from controlling the gases.

**Figure 12.20** Scientists use ice cores from the Arctic and Antarctic to obtain information about carbon dioxide levels in the atmosphere over hundreds of years. They analyze gases in air bubbles trapped in the ice.

## What Are We Doing? What Needs to Be Done?

Most Canadians, as well as citizens around the world, believe we must take action now. Agreements like the **Kyoto Protocol** (1997), which has been signed by more than 160 countries, call for countries such as Canada to reduce greenhouse gas emissions from all sources. Unfortunately, the levels and deadlines that have been agreed to will be very difficult for countries, including Canada, to meet.

D46 *Inquiry Activity* Toolkit 2

**SKILLS YOU WILL USE**
- Recording and organizing data
- Analyzing patterns

# Make Your Own Greenhouse

## Question

What happens to the temperature inside a sealed glass container when a strong light shines on the container?

**CAUTION:** Do not tap the glass thermometers against other objects.

## Materials & Equipment

- 2 large Erlenmeyer flasks
- 1-holed rubber stopper to fit the flask
- thermometer to fit the hole in the rubber stopper
- second thermometer
- watch or timer

## Hypothesis

Suggest what might happen when sealed and unsealed flasks are placed in a strong light. Then, propose a reason to explain your statement.

## Procedure

1. Your teacher will provide you with a rubber stopper for one of the flasks. A thermometer has been carefully pushed through the hole in the stopper.
2. Gently push the rubber stopper onto the neck of one flask. The thermometer should be several centimetres above the inside bottom of the flask.
3. Leave the second flask open (Figure 12.21).
4. Prepare a data table similar to Table 12.2. Measure the temperature of the air inside the sealed flask. Ask a partner to check the measurement, and then record the temperature in your data table.

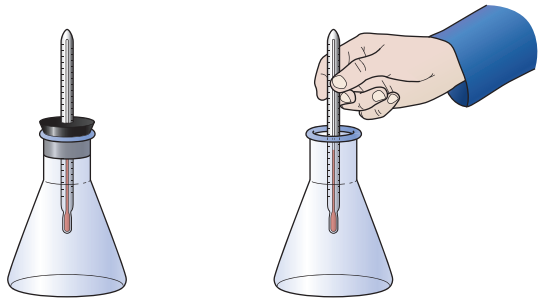


**Figure 12.21** Set-up for activity

5. Hold the second thermometer so that it is not touching the inside surface of the open flask. Measure the temperature of the air inside the open flask. Ask a partner to check the measurement. Record the temperature in your data table.
6. Place the two flasks in a safe place under a strong light or in sunlight for two minutes.
7. Repeat steps 4 and 5, without moving or shading either flask.
8. Take further measurements until your data table is complete.

**Table 12.2** Temperature in two flasks

| Time (min) | Temperature of Sealed Flask (°C) | Temperature of Open Flask (°C) |
|---|---|---|
| 0 (starting) | | |
| 2 | | |
| 4 | | |
| 6 | | |
| 8 | | |
| 10 | | |

## Skill Builder

9. Follow your teacher's directions for drawing a graph for the data you have collected.

## D46 *Inquiry Activity* (continued)

### Analyzing and Interpreting

**10.** Describe the pattern(s) shown by the two lines on your graph.

**11.** Compare this activity with the description of the greenhouse effect earlier in this section. How are they similar?

**12.** Compare this activity with the description of the greenhouse effect earlier in this section. How are they different?

**13.** Suggest a reason for using the open flask in this activity.

### Forming Conclusions

**14.** Suggest one or more reasons to explain the two patterns in temperature measurements that you have observed in this activity.

## D47 *Decision-Making Analysis*

Toolkit 4

**SKILLS YOU WILL USE**

- Gathering information
- Summarizing information

# Reduce, Re-use, Recycle, Recover

### Issue

To find personal choices that might affect greenhouse gas emissions. To consider ways to use fewer products, reduce waste, and decrease energy use.

### Background Information

Every day, Canadians buy, use, and throw away huge amounts of material in all types of useful products and the packaging that comes with them. Heat is involved in manufacturing, packaging, transporting, and storing these products. And then we must deal with what we throw away. For example, Ontario produces more than 9 million tonnes of garbage per year. The City of Toronto alone produces more than 1 million tonnes of garbage per year.

**1.** Use a mind map or chart to brainstorm examples of how we produce garbage. Set up four categories: at home, at school, in the workplace, and in leisure activities.

**2.** Draw a two-column chart. Print titles for each column: column A: Examples of Garbage; column B: Methods to Reduce Garbage.

**3.** Transfer your brainstorm ideas to column A using the four categories. Leave several blank lines at the end of each category.

**4.** Use column B to suggest how individuals, families, businesses, and institutions, such as your school, can reduce waste.

### Analyze and Evaluate

**5.** Share your chart with a classmate or group. Use a checkmark to indicate which of your ideas were also listed by other students. How many of your ideas from column A or column B were listed by others?

**6.** Using the lines you left blank, add more ideas for each category to your columns.

**7.** With your group, select several of the ideas from column B. Prepare a short class presentation in which each member of your group plays a role in explaining and demonstrating the points your group has selected. In your presentation, include pictures, samples, or video clips of products that you are describing.

# 12.2 CHECK and REFLECT

## Key Concept Review

1. Suggest ways in which heat islands contribute to city temperatures.
2. How do heat islands affect the surrounding regions?
3. Which three gases make up most of Earth's atmosphere?
4. Name four greenhouse gases in Earth's atmosphere.
5. What do scientists measure to estimate global warming? You may have several answers to this question.
6. How is the enhanced greenhouse effect different from the greenhouse effect?

## Connect Your Understanding

7. Suggest reasons why rural areas (away from cities) cool off faster than cities.
8. How is a greenhouse a good model for Earth and its atmosphere?
9. Unlike humans, dogs do not sweat. How can we help dogs to stay cool when outdoor temperatures rise?
10. Planners estimate that, by the year 2025, two-thirds of the world's population will live in cities. What effects do you think this will have on urban heat islands?
11. If carbon dioxide makes up only 0.037 percent of Earth's atmosphere, why are scientists so concerned about the amount of carbon dioxide that humans add to the atmosphere each day?

## Practise Your Skills

12. Create a diagram that compares the natural greenhouse effect with the enhanced greenhouse effect.

For more questions, go to ScienceSource.

## D48 *Thinking about Science and the Environment*

### Read All about It

In this chapter, you have read how human activities add heat and greenhouse gases to the atmosphere. Now it is time to find out how this information has been reported to the public. Begin your search for "greenhouse gases" at ScienceSource. Select at least three websites.

Read as much as you can and, using your own words, summarize the information. Record the names and URLs of all the websites you have selected. Be prepared to discuss your summary in class.

# 12.3 Managing Heat Issues

**Here is a summary of what you will learn in this section:**

- Global warming and climate change affect the environment.
- Wise use of heat and other forms of energy helps the environment.
- Ontario is developing a variety of alternative methods for energy production.

Ontario and the other provinces, as well as the government of Canada, are all concerned about reducing the use of fossil fuels and the release of greenhouse gases. Many projects, such as wind farms, involve an alternative energy source. Erie Shores Wind Farm is one of the most advanced **wind energy** development projects in Ontario. It includes more than 13 000 acres in Norfolk County and Elgin County along a 29-km stretch of Lake Erie (Figure 12.22). Other alternative energy sources are the Sun's rays, which provide **solar energy**, the heat deep in Earth, which provides **geothermal energy**, and the force of tides and waves in the ocean, which produce **tidal energy**.

A *renewable fuel* can be replaced in a short period of time. **Biofuels** are fuels that are produced from living things such as plants. Biofuels can be used as an alternative to non-renewable fuels such as oil and natural gas. Ethanol and biodiesel are the two main biofuels widely used today. In Canada, ethanol is made from wheat in the western provinces and from corn in Ontario and Quebec. An Ottawa-based company is a world leader in using straw to produce ethanol.

**Figure 12.22** Erie Shores Wind Farm

## D49 *Starting Point*

Skills A C

### Sorting Things Out

Your teacher will provide you with a set of energy tags. Each tag contains a tip for saving energy in your home. By yourself or with a classmate, follow your teacher's directions for classifying the energy tags. Classify by sorting the energy tags into categories so that the tags in a category are somehow related. Give each category a title. Then, record the information on the tags in your Energy Tag Recording Page. Have fun reading, learning about, and classifying your energy tags!

## Energy Use in Canada

**Figure 12.23** Energy is used to produce recreation equipment.

In Canada, energy is used to produce:

- all the products you use, and all the containers you throw away (Figure 12.23)
- your share of the gasoline and other fuels that keep our vehicles moving (Figure 12.24)
- your share of fuels that produce the electricity that you use at home
- your share of the heat used to produce hot water for washing dishes and clothes and for showers and baths

**Figure 12.24** Gasoline and other fuels power a variety of vehicles.

The energy industry and transportation contribute the greatest share of emissions. For individual Canadians, transportation accounts for almost half of greenhouse gas emissions, mostly due to automobile use. Energy use in homes accounts for the other half. We might ask:

- How willing will Canadians be to reduce their use of automobiles and their use of energy at home?
- Are Canadians prepared to reduce energy by recycling and reducing waste as much as possible?
- Are Canadians willing to use and throw away fewer products at home, at school, and on the job?
- Should Canadians and Americans take these actions even if citizens in other countries choose not to?

**D50** *During Writing*

Thinking Literacy

### Point, Proof, Comment

Writers use different strategies to help them record, sort, and identify relationships among the information they gather for their writing. Use a "Point, Proof, Comment" organizer to record notes as you read the next page on the impact of climate change. Your point will be that global warming seems to be causing climate change.

As you read, write down information that supports your point — this is your proof. Record your own thoughts and ideas in the "Comment" part. Use the information in your organizer to write a cause and effect paragraph. Use signal words appropriate to this type of writing to connect your ideas.

# The Impacts of Climate Change

Global warming seems to be causing **climate change**, which we can define as any major change in the climate of a region of Earth that lasts for a long period of time. Changes in Earth's wind patterns, average temperature, precipitation including rainfall, and the number and strength of extreme weather conditions such as floods and hurricanes, may be indicators of climate change. Figure 12.25 shows some of the effects of rising sea levels, increased temperature, and changes in rainfall. Every part of life will be affected.

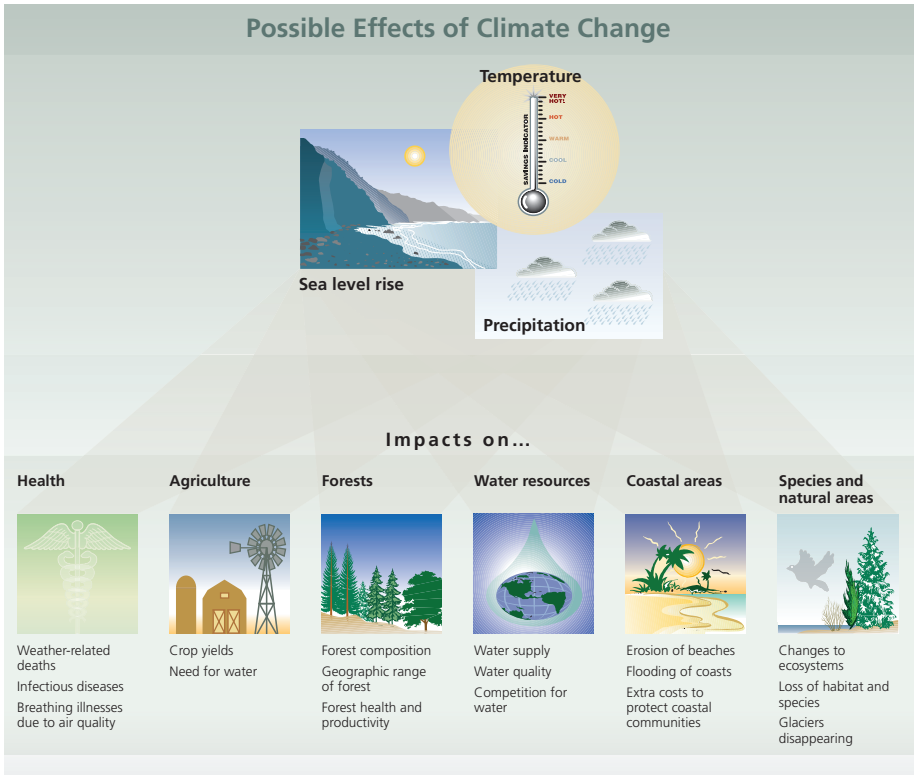



**Figure 12.25** Possible effects of global climate change on Earth

## Canada at Risk

Some results of climate change are already here. Canada's Arctic is warming faster than anywhere else on the planet. Certain regions have already experienced average temperature increases of as much as 3 °C in the past 50 years. Nearly 1 million square kilometres of ocean ice have already disappeared, posing serious problems for seals, polar bears, and people who live in the Arctic.

Canada's forests are also at risk. For example, due to many years of warm winters, a tiny insect called the mountain pine beetle has been slowly moving through the forests of British Columbia and has now entered Alberta. The result? Since 1993, millions of lodgepole pine trees are dead or dying. Scientists have not found a way to combat this tiny killer (Figure 12.26). By 2013, it is expected that the beetle will have wiped out 80 percent of the pine forest.

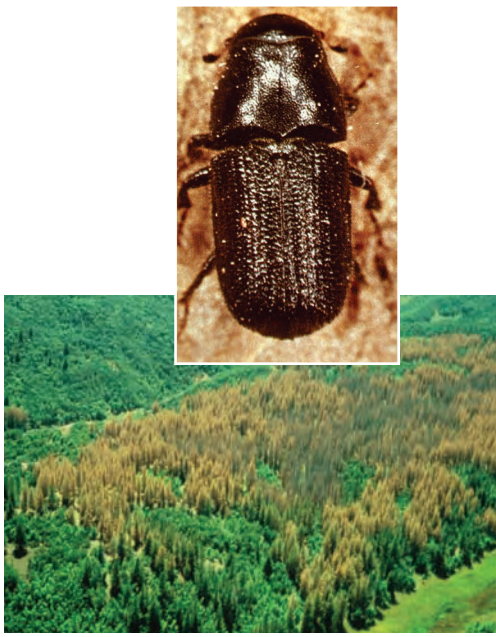


**Figure 12.26** The mountain pine beetle is only the size of a grain of rice but in huge numbers can have a very big effect. Mountain pine beetles and a fungus they carry kill trees. The needles turn a bright red, showing where the tiny insects have been. Colder winters are needed to stop the beetle's spread.

## Solving the Problem of Too Much Heat

If adding carbon dioxide and other greenhouse gases contributes to global warming, then the solution would seem to be obvious — decrease the activities that produce and release greenhouse gases. But this is not a simple problem.

First, all countries do not contribute equally to the problem. Canada and the United States are two of the largest emitters of greenhouse gases. The United States produces 25 percent of the carbon dioxide pollution from fossil-fuel burning—by far the largest share of any country. Also, millions of tonnes of methane are released, due to drilling for oil and gas. And, according to a study by the United Nations, Canada's total carbon dioxide emissions for the year 2002 made Canada eighth on a list of almost 200 countries. Canada is one of the greatest consumers of energy per person, with each of us burning the equivalent of roughly 7700 L of oil per person each year.

One scientific report suggests that major reductions of carbon dioxide emissions will be required by all nations. For example, the United States would need to reduce by at least 80 percent below year 2000 levels by the year 2050. The question is: is such a large reduction possible in so short a period of time?

### Global Warming – The Good News

Listening to the news and reading newspapers and Internet articles may make the current global warming situation seem hopeless. But, it is not. What can one person do?

- First, you can learn more about and support scientists who are studying climate change. Every year, measuring technology improves. This allows us to take different kinds of measurements and to make our measuring more accurate.
- Second, support politicians, organizations, and individual Canadians who are concerned about global warming and who are making efforts to inform Canadians. These efforts should help us begin to repair the environment.
- Third, become aware of the positive steps that countries, organizations, and citizens are taking to inform people and to help make the changes needed to reduce global warming.

- Fourth, continue to learn about Canadian issues related to global warming. Read newspaper, magazine, and Internet articles that discuss greenhouse gases.
- Fifth, discuss your concerns with your friends, family, school community, and local government representatives. Writing letters that contain accurate scientific information is often a useful means of communication.

The images in Figure 12.27 will help you to understand other aspects of the global warming issue and to see that some positive steps to combat global warming are being taken.


**Figure 12.27 (a)** Ontario has banned the sale of incandescent light bulbs (i) after 2012. New efficient lighting such as compact fluorescent bulbs (CFLs) (ii) use around 75 percent less electricity than standard old-fashioned incandescent bulbs.

**Figure 12.27 (b)** The farmers who grow crops in this field may benefit from global warming. Warmer atmospheric temperatures could produce longer growing seasons. As well, we might be able to grow new crops due to warmer temperatures and a longer growing season.

**Figure 12.27 (c)** A study conducted in 2007 indicates that warmer atmospheric temperatures result in fewer colds in the winter. However, this result was obtained from only a single study; more research is needed.

**Figure 12.27 (d)** Climate change and rising temperatures can lead to drought and the loss of farmland to the desert. Canadian technology is helping scientists in Israel to make clean water available. This technology can then be used in other places where a lack of water currently prevents crops from being grown.

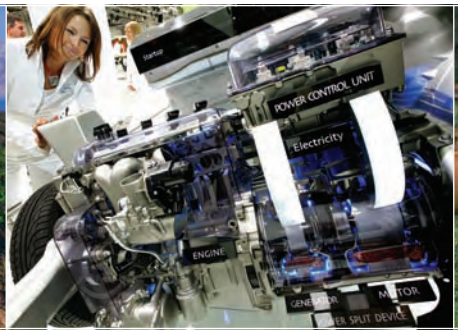



**Figure 12.27 (e)** Technologies that exist today have already produced hybrid automobiles. These vehicles consume less gasoline than other vehicles by running partly on electricity from rechargeable batteries inside the vehicle.

**Figure 12.27 (f)** A study conducted in 2003 in Australia found that the amount of methane gas had remained steady for four years. Methane is released into the atmosphere from the production of rice, cattle, and sheep; from landfills; from natural wetlands; and from the mining and use of fossil fuels such as coal, oil, and gas.

## What Is Happening in Ontario?

Today, much of Ontario's electricity is produced by burning coal to produce electricity and by using uranium in aging nuclear power plants. These methods release greenhouse gases and heat into the environment.

Ontario is moving toward producing energy that does not involve burning fuels. These sources of electrical energy are called **green renewable power** because they do not harm the environment by producing gases or heat pollution. The newer methods of green renewable power that Ontario is developing include solar energy, wind energy, bioenergy, and geothermal energy (Figures 12.28, 12.29, and 12.30). Since 2003, Ontario has begun more than 60 renewable energy projects (Figure 12.31).

**Figure 12.28** Solar energy panels such as these can produce electricity for thousands of homes.

**Figure 12.29** The power of the wind is everywhere.

**Figure 12.30** In winter, geothermal heat pumps, like this one in Iceland, use liquid in underground pipes to draw heat from deep within Earth. In summer, the pumps work in reverse, extracting heat from inside a building and discharging it underground. In Ontario, about 8500 homes and 500 buildings have already installed geothermal systems, which eliminate the usual heating and air-conditioning systems.

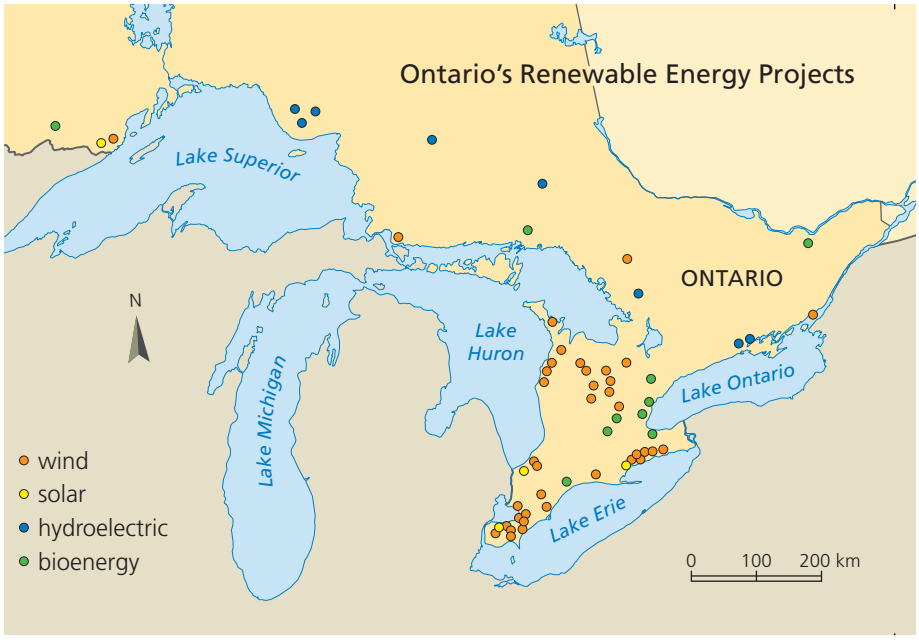



**Figure 12.31** Some of the dozens of renewable energy projects in Ontario

**SKILLS YOU WILL USE**
- Recording information sources
- Stating a conclusion

# Cutting Energy Costs

## Issue

How can our community reduce the financial and environmental costs of home energy use?

## Background Information

A home is more than just rooms, furniture, and a roof. It is an interactive, constantly changing set of spaces that includes a system for heating and cooling. In part, a home provides living and sleeping spaces and appliances for controlling the temperature of all spaces, water, and food.

Green buildings are structures that are built or refitted to use less energy and less water than the average structure. Many consumers and business owners realize that living and working in a green building is good for the environment, can provide a healthier living space or workplace, and can also save money.

We spend up to 90 percent of our time indoors. This requires year-round energy use for heating and cooling. In Canada, heating indoor spaces accounts for 60 percent of home energy use. Energy-reducing strategies mean that less fuel may be necessary to heat buildings, and using less fuel means producing fewer greenhouse gases. There are many ways to reduce the energy use of a building. A green roof is one way. Using new designs for windows is another. Around 20 percent of the heat lost from an average home is through the windows.

1. Select a method to reduce home energy use and/or reduce its effect on the environment from the list of homes provided. Or, choose your own method to research, after consulting your teacher.
   - a home that uses geothermal heating or a heat pump
   - a home that uses high levels of insulation in the attic and walls as well as energy-saving windows and a high-efficiency furnace
   - a home that uses solar energy to heat water
   - a home that includes a green roof
2. Research your topic. Begin your research at ScienceSource. Find out how the method you chose reduces energy use and/or reduces effects on the environment. 
3. Prepare a report in your own words that provides background information and images. Include a glossary (words and their meanings) of the new vocabulary you have learned in your research. Also, include a bibliography of websites (URLs and website names) or reference materials you have used in your research.

## Analyze and Evaluate

4. Form a group with classmates who have chosen other methods. Share your report. The group should try to reach consensus (agreement) on one or two of the methods that are the best choices for your community. Be prepared to report your decisions to your class.
5. How did the class groups rate the methods? Design and complete a chart to summarize the results.
6. While the groups are reporting to the class, record some of the reasons why they chose these methods.
7. Why is more energy used in Canada for indoor heating compared to most other countries? Suggest several reasons.

# 12.3 CHECK and REFLECT

## Key Concept Review

1. Name several predicted effects of climate change.
2. For individual Canadians, which two human activities produce the greatest proportion of greenhouse gas emissions?
3. Describe two ways that Canada's environment is at risk from global warming.
4. List four ways that individual Canadians use energy produced from oil.
5. Briefly describe how geothermal heat pumps provide heating and cooling to buildings.

## Connect Your Understanding

6. Design and draw a chart to name and summarize three kinds of green renewable power being developed in Ontario. Include a small drawing or piece of clip art for each.

## Practise Your Skills

7. Figure 12.27 on page 363 illustrates six categories of possible impacts (changes) due to global warming. Select one of these categories. Then, write a sample "Letter to the Editor" for your community newspaper in which you discuss this category using your own words.

For more questions, go to ScienceSource.

## D52 *Thinking about Science and the Environment*

### It's Your Choice

Dr. Jane Goodall, the well-known scientist, has remarked: "Every individual matters. Every individual has a role to play. Every individual makes a difference." This is especially true in dealing with global climate change.

#### What to Do

Your teacher will provide you with a list of Terrific Tasks you can do. Use the rating form provided by your teacher or develop your own rating form in your notebook. Rate each item as one of the following:

- Use 1 if you feel you can accomplish this Terrific Task.
- Use 2 if you feel that you need more information before you can accomplish this Terrific Task.
- Use 3 if you think this Terrific Task is beyond your control or if you would be unwilling to try it.

#### Consider This

With a classmate or as a whole class, discuss the following question.

How many of the Terrific Tasks did you rate as number 1; as number 2; as number 3?

**Figure 12.32** The Energy Star label indicates an energy-efficient consumer product.

DAILY PLANET

# Making Connections

**Jay Ingram**

Jay Ingram is an experienced science journalist and is the host of *Daily Planet* on Discovery Channel Canada.

## The Snake and the Squirrel

Heat is something we feel. We love it in winter and try to avoid too much of it in the summer. We are pretty sensitive to heat, right? Maybe, but our sensitivity is nothing compared to that of the rattlesnake.

Rattlesnakes are superb hunters. They hunt mostly in the dark, watching out for small mammals like ground squirrels. But they are not actually *watching* in the way you might think. For one thing, they are not using their eyes. They are using pit organs in their muzzles just behind their nostrils. And they are not looking, they are *scanning* for infrared radiation — what we call heat.

Infrared is the same as light, except that its wavelengths are too long for our eyes to see. When you turn on the stove element, it is glowing in the infrared long before you can actually see it turning red.

Body heat is infrared radiation. The body heat of a small mammal like a ground squirrel is a beacon to a rattlesnake. Pitch dark or not, it does not matter—the snake can target and strike without ever using its eyes.

This ability gives the snake a deadly piece of hunting weaponry, but, as often happens in nature, there is a defense. In this case, it is employed by the California ground squirrel. When confronted by a rattlesnake, the squirrel does something called "tail flagging," waving its tail rapidly back and forth in front of the snake. At the same time, the squirrel pumps blood into its tail to make it hot.

Imagine what this is like for the snake! Instead of a tempting, vulnerable target, it is suddenly confronted with overwhelming fireworks of infrared, lashing back and forth, suggesting a much larger prey than it had reckoned with. In the lab, the snake hesitates and even backs off.

This defense is tailored specifically for rattlers: squirrels do not bother to heat up their tails when faced with gopher snakes, which lack the infrared receptors. But the irony is that the squirrel itself cannot detect infrared, so it is only doing what has worked for thousands of its ancestors in the past — without knowing why.

# 12.0 Chapter Review

## Assess Your Learning

### Key Concept Review

1. What is heat pollution? (k)
2. Describe a heat island. (k)
3. Name two problems resulting from the operation of nuclear power plants. (k)
4. What is biofuel? Name two types of biofuels. (k)

### Connect Your Understanding

5. Developing Atlantic salmon (salmonids), shown on the left, prefer a water temperature of 17°C. If the water temperature varies by even 1°C, there is a reduction in growth of 8 percent. Suggest how global warming might affect the growth of salmon and other fish species. (t)
6. How is global warming different from climate change? (k)
7. How can you and your family contribute to reducing your greenhouse gas emissions? (a)
8. Why is Canada especially sensitive to climate change? Use the map below to help you suggest several reasons. (t)


### After Writing

Thinking Literacy

**Reflect and Evaluate**

Exchange the cause and effect paragraph you wrote on the impact of climate change with a partner. Compare the signal words you and your partner used in your paragraphs. Were there any similarities or differences?

How did knowledge of the cause and effect pattern of writing help you as you read your partner's paragraph? What other science topics would best suit a cause and effect pattern?

**ACHIEVEMENT CHART CATEGORIES**

(k) Knowledge and understanding (t) Thinking and investigation (c) Communication (a) Application

9. Why do you think most of Ontario's renewable energy projects are located in southern Ontario? Suggest several reasons (see Figure 12.31 on page 364). t

10. Although we have many concerns about global warming, there are also positive signs. Look back through this chapter. Examine the information sections and the illustrations. Suggest several positive indicators that provide hope that humans can reduce our use of energy and Earth's resources. t

11. Today, many Canadians are concerned about greenhouse gases released into the atmosphere by transportation (cars, trucks, ships, airplanes). Suggest some of the changes that could be made to reduce these emissions. In your answer, consider attitudes, how we obtain data on emissions, publicity, and vehicle design. a

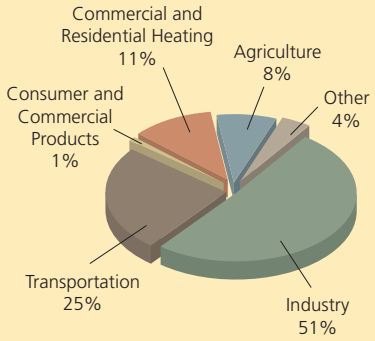
## Practise Your Skills

12. Examine the pie chart on the right that shows greenhouse gas production in Canada. Identify the three major sources of greenhouse gases in Canada. k

13. Design and create a mini-poster or website home page to describe one type of alternative energy source that is in use or is being developed in Ontario. Begin your search at ScienceSource. For a Web page, include links to related websites. Include a relevant, creative title. a

### Unit Task Link

Canadians endure some of the coldest outside temperatures in the world, so our country is one of the greatest consumers of energy. People's reliance upon energy is a major factor in the warming of the atmosphere. One way to reduce energy use is to improve the quality of insulation used in Canadian buildings.




## D53 Thinking about Science and the Environment

### Take Action Now

In this unit, you have learned that heat causes changes in the environment. Many of these changes may not be good for the environment or for humans.

#### What To Do

By yourself, then with a partner or group, develop an action plan to reduce the amount of energy used and released by you, your family, and your community. In your action plan, consider what you want to do and how you will communicate your information to others.

#### Consider This

1. Who will your audience be?
2. Suggest a time line for your action plan.
3. How will you "deliver your message" to your intended audience?

# UNIT D Summary

## 10.0 Heat causes changes in solids, liquids, and gases.

### KEY CONCEPTS

- Energy can be transformed and transferred.
- Heat is the transfer of thermal energy.
- Heat affects the volume of solids, liquids, and gases.
- Heat is transferred in three ways: conduction, convection, and radiation.

### CHAPTER SUMMARY

- There are different forms of energy. Energy can be changed from one form to another.
- Thermal energy is the total energy of all the particles in a sample of matter. Temperature is the average energy of all the particles.
- Heating results in the expansion of solids, liquids, and gases. Cooling results in the contraction of solids, liquids, and gases.
- Heat is obtained by burning fossil fuels, from uranium, and from renewable heat sources. Heat is produced in all energy transformations.
- Cooking food and heating buildings are examples of human activities that transfer heat through conduction, convection, and radiation.

## 11.0 Heat plays an important role in nature.

### KEY CONCEPTS

- Earth's atmosphere is divided into five layers.
- Earth's crust is constantly changing because of conduction and convection.

### CHAPTER SUMMARY

- The layers of Earth's atmosphere are: the troposphere, the stratosphere, the mesosphere, the thermosphere, and the exosphere.
- Radiant energy from the Sun affects natural systems, including the water cycle and the weather.
- Ocean currents contribute to the movement of thermal energy and help to balance the extremes of temperature on Earth's surface.
- The rock cycle helps us to understand how heat causes changes in Earth.

## 12.0 Heat technologies offer benefits and require choices.

### KEY CONCEPTS

- Human activities produce heat and greenhouse gases.
- Each person can play a role in protecting the global environment.
- Climate change may produce huge effects on ecosystems.

### CHAPTER SUMMARY

- Heat pollution is heat that has negative effects on an ecosystem.
- Gases in Earth's atmosphere that trap heat and warm the planet are called greenhouse gases.
- Global warming describes the worldwide increase in average temperature that may lead to climate change.
- Ontario is developing a variety of alternative methods for energy production.

# Keeping Our World Cool and Our Homes Warm

## Getting Started

Insulation materials inside the outer walls of buildings help prevent heat loss to the outside air. By using insulation, Canadians can save energy and reduce the amount of greenhouse gases produced.

## Your Goal

To determine how the properties of insulation materials relate to heat loss

## What You Need

- 2-L clear soft drink bottle with screw cap
- selection of insulating materials
- crushed ice or snow in a large cooler
- thermometer
- hot water (50–60°C)
- elastic bands
- stopwatch
- putty or modelling clay
- ruler

**CAUTION:** Be careful when handling hot water.

## Steps to Success

1. Create a table to record your time and temperature observations. Measure and record room temperature.
2. Punch a hole though the screw cap. Insert the thermometer so that the tip rests about halfway down in the bottle. The thermometer should extend above the cap so that you can observe the temperature readings. Use putty or modelling clay to seal the entry point.
3. Remove the screw cap with the thermometer and put it in a safe place.
4. Choose one of the materials to be tested as insulation. Wrap the bottle firmly and secure the insulation blanket with elastic bands. The insulation should be exactly **2 cm** thick on all surfaces of the bottle, including the bottom.
5. Add 1.7 L of hot water to the bottle. Immediately screw on the cap, which holds the thermometer. Start the stopwatch. Record the time and water temperature. Place the bottle into the snow (ice) cooler.
6. Record the temperature every 2 min for 20 min or until it approaches room temperature.
7. Pour the water out of the bottle. Repeat steps 3 to 5 with the other insulating materials.
8. Finally, repeat the procedure with a bottle that has not been wrapped in any material. This is your control.
9. Using the data in your table, graph your results for each insulating material you tested and the control.
10. List the samples in order from best insulator to worst insulator.
11. Examine the physical properties of the samples. Are there any common traits among the good insulators? The poor insulators? What makes a material a good insulator?
12. When you have finished the activity, follow your teacher's instructions for recycling the plastic bottles and other materials, if possible.

## How Did It Go?

13. Would the insulating materials that you tested be equally effective in preventing heat from entering a building? How would you test this? Why would builders or home-owners be interested in knowing this?
14. Were all of the groups' results the same as yours? What might cause your findings to be different from those of others?

# UNIT D Review

## Key Terms Review

**1.** Design and draw a mind map that includes the terms below and any other new terms you have learned in this unit.

- atmosphere
- climate change
- conduction
- convection
- energy converter
- global warming
- greenhouse gas
- heat
- heat pollution
- ocean current
- particle theory of matter
- radiation
- rock cycle
- temperature
- thermal energy
- volcano
- water cycle
- wind

Give your central idea an original title, and use the titles of the three chapters as the main headings on your map. Use dashed lines to connect similar ideas that occur in more than one part of your map. Write a phrase or sentence along each connecting line to explain why you connected these ideas. (k)

## Key Concept Review

### 10.0

**2.** Provide three or more examples of energy transformations in which thermal energy is produced. (t)

**3.** What are some examples of fossil fuels? (k)

**4.** Explain the differences between thermal energy, heat, and temperature. (t)

**5.** Explain how convection heats up your bedroom in the winter. (t)

**6.** Identify the form(s) of energy described in each of the following situations. You may need to list more than one form of energy for some of these situations. (k)

(a) studying for a science test at home

(b) eating an apple as a snack

(c) toasting bread

(d) using a microwave oven (**Hint:** Think carefully here.)

**7.** Use a Venn diagram with two circles to compare and contrast fossil fuels and renewable energy sources. (k)

**8.** Describe and illustrate three situations in which heat is transferred by conduction, convection, and radiation. (t)

### 11.0

**9.** What is the atmosphere? (k)

**10.** List the steps in the formation of raindrops in the atmosphere. (t)

**11.** Name the changes of state that are part of the water cycle. Indicate the change(s) that release heat and the change(s) that require heat. (k)

**12.** Why is it important for scientists to study ocean currents and their patterns? (t)

**13.** List the geographic features that make up Earth's crust. (k)

**14.** Name two events that may occur as a result of the movement of the plates below Earth's crust. (t)



ACHIEVEMENT CHART CATEGORIES
(k) Knowledge and understanding (t) Thinking and investigation (c) Communication (a) Application

**15.** How does heat play a role in the formation of igneous and metamorphic rocks? t

**16.** Less than one-billionth of the Sun's energy reaches Earth. What happens to this energy? (**Hint:** check Figure 11.7.) k

## 12.0

**17.** Name three or more energy converters that you use often. t

**18.** What do we mean when we say "greenhouse effect"? k

**19.** List three common ways that nitrogen oxides are released into Earth's atmosphere. k

**20.** Describe two possible ways of reducing the emission of carbon dioxide into Earth's atmosphere. k

**21.** List three Canadian animals or plants that may be at risk as a result of global warming. Describe why each one is at risk. t

## Connect Your Understanding

**22.** Chapter 12 provides an example of heat pollution that describes how heat affects the amount of oxygen in a river or lake. Describe another example of heat pollution and its effects on the environment. t

**23.** As you hold a cup of ice cream, heat transfers from your hand to the cup and then to the surface of the ice cream touching the cup. What type of heat transfer does this describe? k

**24.** Identify a human activity that uses a large amount of electrical energy. Describe its effect on the environment. t

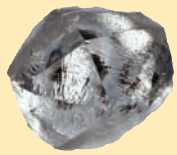
**25.** Infrared radiation can pass through transparent solids (like the windshield of a car) and colourless gases (like the air inside a car). On a sunny day in winter, the air in a closed car can become quite warm. Suggest a reason to explain why this happens. (**Hint:** Think about the other two types of heat transfer.) t

**26.** Figure 10.31 on page 303 compares the motion of particles to that of curling rocks. Select your own real-world example to make a comparison with particle motion. t

**27.** How does the engine of an automobile act as an energy converter? t

**28.** Compare the inner and outer cores of Earth. t

**29.** The word diamond comes from the Greek word *adamas*, which means indestructible. What role does heat from Earth play in producing diamonds and other valuable gems? t



**30.** Draw a Venn diagram with three circles. Label the circles *igneous rocks*, *sedimentary rocks*, and *metamorphic rocks*. Then, use the information you learned in this unit to fill in the circles. k

**31.** Installing double-pane and triple-pane windows on a building greatly reduces heat loss. Which of the three forms of energy transfer are reduced by these energy-efficient windows? t

**32.** Using satellite images, researchers have found that city climates influence the growing seasons of plants up to 10 km from a city's edges. Growing seasons in 70 cities in eastern North America were about 15 days longer in urban areas than in rural areas outside a city's influence. How would this affect the type of crops that farmers plant in and near cities? (a)

**33.** Would you expect higher air temperatures in summer above a city or above its surrounding suburbs? Provide reasons for your answers. (t)

**34.** Fill in a number chart similar to the one below, using information in this unit. You may include more than one set of information in each box. The first box has been completed for you. (k)

| Number | Chapter | New Information and Descriptions |
|---|---|---|
| 2 | 10 | two types of melted rock: magma (underground) and lava (on the surface) |
| 2 | 11 | |
| 2 | 12 | |
| 3 | 10 | |
| 3 | 11 | |
| 3 | 12 | |
| 4 | 10 | |
| 4 | 11 | |
| 4 | 12 | |
| | | |

**35.** Could wind energy be an effective method of producing electricity in your region of Ontario? Provide reasons for your answer. (a)

**36.** Scientists estimate that approximately 23 billion tonnes of carbon dioxide ($CO_2$) are added to Earth's atmosphere every year. That is more than 700 tonnes every second.

(a) Name several human activities that produce $CO_2$. (t)

(b) How is $CO_2$ production related to the enhanced greenhouse effect? (t)

**37.** In April 2007, the Ontario government announced several renewable energy projects, including one of the world's largest solar energy farms. Why is solar energy considered to be a renewable form of energy? (t)

**38.** Think about the human activities that are important in your region of Ontario. For example, your region might include a high level of agriculture (farming), forestry, fishing, or mining. Develop a list of five or more human activities in your region of Ontario that depend on knowing about the weather. (t)

**39.** Think back to the new ideas and activities related to heat and the environment that you have seen in this unit. What changes have you already made in your daily activities? What changes do you plan on making? What further ideas do you think you need to research or explore? You could respond to these questions in writing or in an original, visual form. (c)



ACHIEVEMENT CHART CATEGORIES
(k) Knowledge and understanding (t) Thinking and investigation (c) Communication (a) Application

## Practise Your Skills

**40.** Draw a circle and write "Greenhouse Gases" inside it. Draw four lines radiating out of the circle, and draw a small circle at the end of each line. Write "water vapour" in one of the circles. Write the names of three other greenhouse gases in the other small circles. To each of the greenhouse gas circles, attach a line that ends at a description of a common source of the gas. To each source, attach a comment that indicates whether it is necessary to reduce emissions of this gas or not. t

**41.** Construct a comparison matrix that compares four human activities that produce a very large amount of heat with the characteristics "heat the atmosphere" and "heats natural water systems." t

## Revisit the Big Ideas

**42.** When the Sun shines on a metal doorknob on the outside of a home, what happens to the inside part of the doorknob? Write a paragraph to explain this. Use the words "heat," "particle theory," and "conduction" in your answer. t

**43.** You have learned how humans need and use heat and about the effects of adding heat to the environment. Write a letter to the editor of your school or regional newspaper to describe how your ideas changed since you began studying this unit. c

**44.** Create a home page for a website that informs viewers about our concerns for the environment as discussed in Chapter 12. Add additional Web pages and links that provide further information. Start your search at ScienceSource. c

## D54 *Thinking about Science, Technology, Society, and the Environment*

### Tie It All Together

At the beginning of this unit (pages 274 and 275), you learned about the concept Think Globally, Act Locally. You read about the efforts and creativity of some Ontario residents who care about energy and Earth's environment. Now, it is your turn! Brainstorm a list of climate awareness projects that you, your classmates, your family, and/or your community could develop in your local area. Choose one of these projects and create your own EAP — Environmental Action Plan. Design an original mini-poster to illustrate your EAP. Consult with your teacher to determine how your EAP can be put into effect.