Section 9.3 Taking Action (Student textbook pages 370 to 381)

In this section, students will consider the debate about climate change and be challenged to make informed decisions about their own actions. Students will learn about carbon footprints and how different organizations, including governments, are trying to encourage the reduction of greenhouse emissions.

Common Misconceptions

- Some of the same issues that may have come up in Chapter 7 may resurface here. Some students may still believe that climate is not changing. Remind students that in the scientific community, there is no argument about the fact that the climate is changing. The key issue is what is driving this change—natural forces or human forces. This topic, which has come up throughout the unit, can now be fully challenged by having students confront their own bias and look at the body of evidence presented. Some students may feel strongly against human causes of climate change, based on the opinions of family and/or friends. That is fine as long as students are able to assess evidence and support their point of view.
- There may be confusion about the Kyoto protocol and what Canada is and is not required to do to meet its Kyoto obligations. The Kyoto protocol requires countries to reduce their emission by a particular target below a baseline set by 1990 emissions. The period during which the reduction will take place is 2008 to 2012. Canada ratified the treaty and agreed to reduce emissions by 6 percent over the 1990 baseline. At this point it is highly unlikely that Canada will meet its targets.

Background Knowledge

Climate change may be regarded as the defining issue for this generation of students. It is highly complex. Solutions will require radical shifts in the way our world works. Moving away from a carbon-based economy means changing virtually every aspect of how Canadians work and live. Many of the ideas that are presented to students, or that they will find in their research, provide relatively easy changes (such as changing to high efficiency light-bulbs). These changes will soon be fully implemented and more difficult decisions, about transportation, food choices, design of urban areas, etc. may need to be made. This will require behaviour change on a massive scale. For example, urban sprawl can only work in a car-based society. We may run out of space and need to reduce our dependence on cars. Single-family homes with large yards, which are, to many, the current symbol of success, may not exist in newly designed neighborhoods. People may need to be convinced that high-density living (for example, townhouses) is desirable.

There are many different carbon calculators available. Some may use different assumptions and may calculate footprints differently. Carbon calculators should take the entire "product life cycle" into account. Different foods, for example, should be calculated for their carbon contents in different ways, depending on how they were produced (e.g., mass agriculture using fossil fuel-based technology such as tractors) and how far and by what means they were transported (local produce versus shipping or trucking across the country or continent). If students are using a calculator from the Internet, they need to understand what is being calculated and how.

The Canadian government is expected to develop a national cap-and-trade system in the next few years. Ontario released a plan to develop and implement its own cap-and-trade system by 2010. Ontario is a participant in the Western Climate Initiative (WCI), an international cap-and-trade program involving Mexico, seven western American states, and four Canadian provinces. The WCI is set to begin trading in 2012. The Ontario system would feed into the WCI. A national cap-and-trade system is being developed in the United States.

Specific Expectations

- **D1.2** assess, on the basis of research, the effectiveness of some current individual, regional, national, or international initiatives that address the issue of climate change and propose a further course of action related to one of these initiatives
- **D2.1** use appropriate terminology related to climate change, including, but not limited to: *albedo, anthropogenic, atmosphere, cycles, heat sinks,* and *hydrosphere*
- **D2.9** compare different perspectives and/or biases evident in discussions of climate change in scientific and non-scientific media

Most cap-and-trade systems regulate emissions from large industrial emitters (such as oil and gas companies) and cap them at a certain level. If these companies cannot reduce their emissions to meet their cap, they can go on the market and buy 'emissions credits' from another company. Carbon offsets are also traded. These are emissions reductions that have been accomplished by non-regulated organizations. This is a revenue stream for these companies, as they will not be fined for missing a cap if they do not have one and they get paid for the emissions reductions that they are able to make.

Ontario's proposed Green Energy Act would remove many of the barriers faced by alernative energy companies. At the moment, the energy grid is centralized (sources of energy are few and far between, so energy can only be added to the grid in specific places) and is difficult to connect to. The Green Energy Act would require a redesign of the grid so that small producers, such as wind, biofuel, and solar producers, can hook up to the grid and add their energy.

Literacy Support

Using the Text

- Have students personalize the information in this section if they are able. The material is highly relevant to their futures, whether they understand that or not, given the movement of most international governments to address climate change. After students have read about a topic or idea, have them brainstorm ideas about the topic.

Before Reading

- Have students look at the headings to determine the main ideas in the section. This will help them identify the most important information in the text. Students can use this information to organize their learning.
- Encourage students to make a web to help them organize their understanding. They can begin their web based on headings in the section and develop the content as they progress through the material.
- Have students make connections to prior knowledge. Students should be familiar with some of the topics based on prior learning in the section and it is a good idea to encourage them to identify what they already know about the material in the section.

During Reading

- Have students compile a list of questions as they read the text. This will help focus their reading and will serve as an organizer for information they still need to learn.
- Have students work in pairs and check each other's comprehension. Have them stop at every subsection and ask each other two questions about the content. Once they agree on the best answer for each question, they can proceed to the next subsection of text.

After Reading

- Ask each student to write a short, two-sentence summary of the main points of the section. You can then have students work in groups to compare their summaries and agree on one. This can be shared with the class and recorded so it can be used as a review.

Using the Images

- Combine the images in this section with the associated text headings. This can serve as an organizer for the work as they progress through the section.
- Before reading this section, have students look at the photographs and illustrations and relate them to their own experiences. They should be able to relate many of these to their own experiences of shopping or doing laundry.

- Have students refer to Figure 9.22. Discuss what this timeline is showing and what might be expected to happen to the timeline in the future. As climate change becomes more urgent, more and more action should occur.

Assessment FOR Learning		
Tool	**Evidence of Student Understanding**	**Supporting Learners**
Learning Check questions, page 374	Students explain the importance of understanding climate change in order to make decisions about it. They identify actions that contribute most to Canadians' carbon footprint. They identify strategies and create a table that includes actions for reducing their carbon footprint. Students' tables should show that they understand the relationship between their own actions and emissions. Tables should also show relevant and appropriate offsets.	Have students work in groups or complete question 4 as a class to make sure that everyone is engaged. Have students use **BLM 9-10 Developing an Opinion on Climate Change, BLM 9-11 Calculating Your Carbon Footprint**, and/or **BLM 9-12 Taking Action** to support these questions.
Activity 9-4 Talking the Talk, Walking the Walk, page 375	Students choose a reasonable action that they can perform to affect global climate change.	Have students work in groups with members who are able to peer tutor students who are experiencing difficulties.
Section 9.3 Review, page 381	Students demonstrate an understanding of the importance of identifying bias. They explain how modern technology affects decisions about climate change. Students describe the difference between a carbon offset and a carbon footprint.	Have students work in groups or do question 5 as a class to make sure that everyone is engaged. Initiate a class discussion on question 8. Divide students into groups and have them come up with advantages or disadvantages of each system.

Instructional Strategies

- ELL Allow students to demonstrate their beliefs about climate change in alternative ways, such as diagrams. Alternatively, allow enough time for them to write their ideas in their first language and then translate them into English.
- Before beginning the section, have a class discussion to assess what students know about taking action on climate change. Ensure that all students participate, at least with a show of hands. It is likely that many students are familiar with ways in which individuals can make a difference, but may be unaware of international actions.
- **BLM 9-10 Developing an Opinion on Climate Change, BLM 9-11 Calculating Your Carbon Footprint,** and **BLM 9-12 Taking Action** can be used to focus students on actions they can take and how they might be personally involved in a solution to climate change.
- Enrichment—Provide students with **BLM 9-13 Cap and Trade.** Encourage them to learn more about cap-and-trade markets. Use **BLM A-45 Collecting Information Rubric.**
- Enrichment—Provide students with **BLM 9-14 Sources of Alternative Energy.** Interested students can prepare a report on an alternative form of energy based on more indepth research. Use **BLM A-44 Research Project Rubric** to assess students' reports.
- Enrichment—Have students complete **BLM 9-15 The Copenhagen Negotiations** and research the Kyoto Protocol and the Copenhagen Negotiations to better understand the purpose of the negotiations. Act the negotiations out as a class or in groups, assigning research to students based on what they are interested in or capable of. Have all students participate in the negotiations, even if some students are only able to contribute in a small way. Provide students with **BLM G-20 Internet Research Tips.**

- Refer students to Science Skills Toolkit 10 How to Do a Research-Based Project in the appendix of the student textbook to help them with their research projects.
- Provide students with articles about climate change. Have them decide how to identify bias in the articles.
- Have students calculate their carbon footprints on several different online calculators and compare the results.
- This section covers issues that are changing every day on the international scene. Questions currently being asked include
  - If Canada and the United States establish their national cap-and-trade systems, what will this mean to other cap-and-trade systems, such as the proposed Ontario system?
  - Will offsets be allowed in any of these systems and how they will be used?
  - What new provincial and federal legislation will be developed?
  - What will happen in Copenhagen in 2009 when new international treaties are negotiated?
  - What potential sources will meet future energy demand?

Establish interest centres based on these topics and others in the section. Students can add to these centers or perform the activities based on their own interests and at their own pace.

- Develop key visuals such as a flow chart that can be used during class discussion. Develop these on your own, or have the class assist with the development. Provide students with **BLM G-28 Making Decisions Flowchart.**
- Check often for comprehension. Have students engage in discussion or question period about the topics.

Activity 9-4 Talking the Talk, Walking the Walk

(Student textbook page 375)

Pedagogical Purpose

Students will choose one action that they can take to affect global climate change.

Planning	
Materials	Computers with Internet access
Time	20–30 min
Safety	Ensure students follow established Internet safety protocols.

Background

Although many individuals do not feel responsible for greenhouse gas emissions and therefore climate change, it is important to note that almost 50 percent of Canada's greenhouse gas emissions occur in activities under the control of municipalities. One of the largest uses of energy, for example, is pumping and purifying water and wastewater for use in people's homes. Students should be made aware of how important it is for everyone to do what they can to reduce energy use and activities that emit greenhouse gases.

Activity Notes and Troubleshooting

- Encourage students to choose an action that they will actually perform at home for at least one week. They can report back in about how difficult or easy it was to do the action.

- Try ensure that several different actions are chosen. Have students to compare their results in groups made up of others who performed the same action.
- This activity can be extended into a larger project or assigned as homework and done on the students' own time.
- **BLM 9-12 Taking Action** can be used here if it has not already been used. Many of the questions students would research would have relevance to this activity.
- Use **BLM A-45 Collecting Information Rubric.**

Additional Support

- ELL Check often for comprehension, among all students, and especially English language learners. Students may need to demonstrate their understanding of the concepts and the reductions in a variety of ways.
- ELL Encourage students to ask for assistance from peers, and pair them with students who are able to provide support.
- This activity can easily be expanded to create plans for the classroom or even the school. Have students consider what types of actions could be done at a classroom or school level and then develop and implement the plan.
- Provide students with **BLM G-21 Internet Research Tips, BLM G-22 Internet Research Worksheet (A),** and **BLM G-23 Internet Research Worksheet (B)** to use to complete the Procedure.
- Encourage students to make graphic organizers of their results to show how much carbon dioxide they were able to save and to help them organize the information. This can be expanded as they choose different actions. Provide students with **BLM G-28 Making Decisions Flowchart** to help them complete this activity.

Answers

1. Students' answers will vary depending on the action they choose and the ways in which they calculate the footprint for the activity. Have students who chose the same action compare their results to see how similar or different the amounts of savings are.
2. Students' answers will vary depending on the actions they take. Encourage students to think strategically about the second action they choose. Is it one that could be performed by the whole family? How easy or difficult will it be to do both actions?
3. Students' answers will vary. You may wish to have a class discussion to answer this question, based on an average footprint.

Learning Check Answers (Student textbook page 374)

1. Answers may vary, but students should recognize that understanding how climate works will help them make decisions about their impacts on climate.
2. home heating and cooking, recreation and leisure, public services
3. The main strategies are reducing or eliminating the need to burn fossil fuels, and purchasing carbon offsets.
4. Student answers will vary depending on their daily actions and the potential actions they believe would help in their situations. Student answers should demonstrate an understanding of the variety and number of different daily actions that contribute to a carbon footprint. Students should indicate specific actions they could take at home to reduce their need for fossil fuels, in addition to any carbon offset actions they could take when they feel they cannot reduce their need for fossil fuels to carry out specific daily actions.

Section 9.3 Review Answers (Student textbook page 381)

Please also see **BLM 9-16 Section 9.3 Review (Alternative Format).**

1. The source of information is important because it affects whether the information is reliable, accurate, or designed to elicit a certain response.
2. Many people have access to a huge volume of information about climate change. Some of this information is based on scientific evidence and some is not. Many people also use modern technologies that make their lifestyles more convenient. People often do not consider the effects or consequences of using these often relatively inexpensive and easy-to-use technologies.
3. A carbon offset is an activity that captures carbon from the atmosphere (opposite to releasing carbon into the atmosphere). A carbon footprint is a measure of how much carbon an individual uses during a particular time period.
4. Example: hang clothes to dry instead of using an electric dryer, carry reuseable shopping bags, use less electricity by unplugging electrical devices that are not in use.
5. According to the chart, one cheeseburger produces 240 kg of carbon dioxide and 120 kg of methane.
   52 (weeks) × 240 kg carbon dioxide = 12 480 kg carbon dioxide
   52 × 120 kg methane = 6240 kg methane
6. The IPCC is the International Panel on Climate Change, a group run by the United Nations whose job is to review and research all of the information on climate and combine all of the individual research into a single overview of the climate and how it is changing. The group also reviews the possibilities of what may be causing the climate to change.
7. Major milestones are shown in Figure 9.22. Example: Three major milestones in the international response to climate change are: the first World Climate Conference, held in 1979, where scientists expressed concern that human activities may cause significant climate change; the establishment in 1987 of the Montreal Protocol on Substances That Deplete the Ozone Layer in order to phase out these substances; the 1997 Kyoto Protocol to commit nations to reduce emissions of greenhouse gases.
8. Student answers may vary depending on their own bias. Either answer is acceptable, but students should provide support for the system they recommend. If students recommend the cap-and-trade system, they may say that having a cap is beneficial because it limits the carbon that can be produced overall. Students may recommend this system because it rewards companies that produce less carbon by allowing them to sell their credits. Alternatively, students may support a carbon tax because it makes consumers less likely to purchase products that depend on carbon fuel and more likely to purchase alternative items. On the other hand, students may not like the idea of a tax that is levied on consumer goods.

Data Analysis Investigation 9-A Understanding Ice-Core Data

(Student textbook pages 382 and 383)

Pedagogical Purpose

Students will explore the types of data that can be collected using ice-core samples. Students will use this information to analyze climate data from the distant past and make an assessment of patterns they see in their analyses.

Planning	
Materials	Calculator Have graph paper on hand for students as they complete the procedure.
Time	60 min

Background

Russian, American, and French scientists recovered the deepest ice core from the Vostok research station on the Antarctica in 1998. The scientists recovered the ice core from a depth of 3623 m. The Antarctic ice sheet is over 400 000 years old and contains fossil air bubbles that were trapped in snowflakes and then compressed into the ice sheets. Data from the Vostok research station are archived at the United States National Oceanic and Atmospheric Administration (NOAA) World Data Centre for Paleoclimatology.

Ice core samples are taken using a drill that cuts through the ice creating a core that is approximately 10 cm in diameter and then separated into 5 m segments. These cores contain records of the composition of atmospheric gases over time. The ice is melted and the percentage of carbon dioxide in the ice is measured. Techniques such as mass spectrometry and gas chromatography are used to analyze the composition of the different gas isotopes.

Activity Notes and Troubleshooting

- Have students work in groups. You may wish to go through the procedure as a class, or have the students work in their groups but confirm their results for the procedure with you before going on to the rest of the questions.
- Students will probably be challenged by the graphical interpretation in this activity. You may wish to go through question 1 and the first graph as a class to show students how the activity is to be performed.
- Refer students to Math Skills Toolkit 3 Organizing and Communicating Scientific Results with Graphs in the appendix of the student textbook if they need practice creating graphs.
- Have the equation for rate of change (rise/run) at the front of the class. Students will need to perform this calculation in question 4, so they will need a review and probably a sample equation to follow.
- Use **BLM A-22 Project Group Assessment Checklist.**

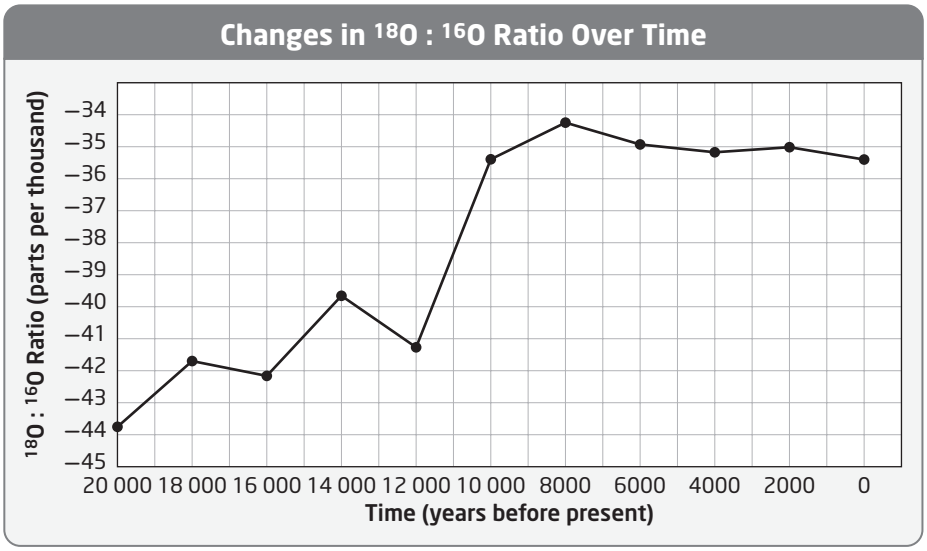
Additional Support

- DI This is an excellent activity for logical-mathematical and spatial learners. Ensure that these students are paired with students who need support.
- ELL This is an excellent activity for English language learners because it focuses on non-verbal expressions of learning.
- Enrichment—Have interested students look up the Vostok research station on the Internet. They can browse through information on how the cores are taken and analyzed and how other isotopes, such as deuterium, are also used as proxy data. Provide students with **BLM G-21 Internet Research Tips.**

- Provide students with **BLM G-37 Organizing and Communicating Scientific Results with Graphs** to support this activity.
- Refer students to Math Skills Toolkit 3 in the appendix of the student textbook for information about organizing data into a graph.
- Allow students to answer question 7 in any way they choose. Provide students with **BLM G-43 Flowchart. BLM A-14 Events Chain or Flowchart Checklist** may be useful for assessing answers to question 7.
- Refer students to Science Skills Toolkit 9 Using Models and Analogies in Science to support Inquiry question 8.
- **BLM A-33 Interpreting Data Rubric** can be used to assess student work.
- Use **BLM A-6 Developing Models Checklist** to assess answers to question 8.
- Use **BLM A-44 Research Project Rubric** to assess answers to question 9. Refer students to Science Skills Toolkit 10 How to Do a Research-Based Project in the appendix of the student textbook.

Organize the Data Answers

1. and **2.**



3. a. −38.05

b. Above: 12 000, 14 000, 16 000, 18 000 and 20 000 (years before present)
Below: present and 2000, 4000, 6000 and 10 000 years before present

c. cooler-than-average

Answers

1. One cold period occurred between 6000 and 20 000 years ago. There was significant warming around 5000 years ago and that warming is still present.

2. The average global temperature was warmed since 20 000 years ago.

3. Carbon dioxide and methane concentrations have both increased from 20 000 years ago. Methane concentration shows a significant drop about 16 000 years ago. The graph shows that carbon dioxide concentration stayed fairly constant over this time. Temperature change and gas concentrations climbed from 6000 years ago to 4000 years ago, but temperature increased most significantly. Methane has increased from 4000 years ago to present, but from the graphs it appears that temperature change and carbon dioxide concentration have stayed relatively constant, with some peaks and valleys in temperature change.

4. From the graphs, it appears that the carbon dioxide concentration 20 000 years ago was approximately 190 ppm and the methane concentration was approximately 390 ppm.

For carbon dioxide:

$$\text{Rate of change} = \frac{\Delta y}{\Delta x} = \frac{(388 \text{ ppm} - 190 \text{ ppm})}{20\,000 \text{ yr}}$$
$$= 0.0099/\text{yr}$$

For methane:

$$\text{Rate of change} = \frac{\Delta y}{\Delta x} = \frac{(1745 \text{ ppm} - 390 \text{ ppm})}{20\,000 \text{ yr}}$$
$$= 0.0678/\text{yr}$$

5. Ice-core data show that concentrations of greenhouse gases have increased with an increase in global temperature.

6. The concentrations are probably very accurate as they are deposited annually and summer temperatures would not be high enough to cause a melt back. A few hours of strong sunlight and the snow will form an airtight crust, holding in the captured gases until it melts.

7. matter and gases in the air are brought to Earth's surface when it rains or snows→different oxygen isotopes influence the temperature at which the ice freezes→these layers are set down annually→when ice cores are analyzed, the ratios of different isotopes indicate whether the temperature was warmer or cooler

8. Students models should show how different layers can contain different information. If the layers are sampled and viewed in the correct order, as they would be in an ice core, then hypotheses can be developed about how the sequence of layers occurred.

9. Vostok is warmer today than it was 20 000 years ago. At that time, the average temperature was approximately –66°C.

Inquiry Investigation 9-B Evaluating the "Food Miles" Initiative (Student textbook page 384)

Pedagogical Purpose

Students will consider support for the idea of buying locally grown food items by analyzing the carbon emissions required to stock local or imported items in grocery stores. They will use the data to develop and support their preferred strategy: buying local or buying global.

Planning	
Materials	Calculator
Time	45–60 min

Background

There are several key features of local food initiatives. Given the greenhouse gas emissions created by the transportation sector, many people believe that reducing the distances that foods have to travel is going to reduce the overall footprint of the foods. As this investigation shows, however, this is not always true. The full footprint of food must include the emissions that take place during production. If production requires a greenhouse, for example, it will use more energy than a food grown in a naturally hot climate.

Food security is a growing concern that has become associated with local food initiatives. One of the key outcomes of ongoing global warming will be a reduction in the amount of arable land. This will likely cause food shortages and increases in prices. Many local food advocates believe that shifting to local food production not only will lower greenhouse gas emissions, but will also provide security of food sources. Ensuring that there is adequate production of food in a region means that future problems can be avoided.

Activity Notes and Troubleshooting

- Determine whether or not there is a food charter in your area. If there is, bring information about the charter to class to discuss. Ask the class to consider more than just the distance food must travel from source to plate. For example, ask students how much of the local economy they think is based on agriculture.
- Have students do a quick inventory of their fridge before this investigation. During a class discussion, figure out a rough estimate of how much food at home is local versus imported.
- Complete the procedure as a class and have the total carbon footprint of each item at the front of the class.
- Food labelling in many parts of Europe includes the total greenhouse gas emissions of producing the food. Lead a discussion about whether this would be a good system for Canada.

Additional Support

- Some students may have lived in other areas of the world. Have these students discuss what types of food they ate and whether the food was local or imported. This can be extended to a discussion of how many students have backyard or container gardens for vegetables.
- Have students create a plan or a model of a community garden that could provide fresh produce for the school. Students can calculate the carbon footprint of the different foods and compare them to the same produce available in the grocery store.

- Pre-assess what students know about local food initiatives by having class discussion. Ensure that all pupils participate at least minimally with a show of hands to determine understanding. Use this assessment as a baseline for their learning.
- Provide students with **BLM G-20 Research Worksheet** to support them when answering question 4.
- Use **BLM A-5 Investigating an Issue Checklist, BLM A-33 Interpreting Data Rubric,** and **BLM A-44 Research Project Rubric** for assessment.

Organize the Data Answers

1. and **2.**

Food	Source	Total GHG Emissions (kg CO_2/tonne product)
Apples	New Zealand United Kingdom	185 271.8
Onions	New Zealand United Kingdom	184.5 170.1
Tomatoes	Spain United Kingdom	630.0 2394.0
Lamb	New Zealand United Kingdom	692.6 2894.1

Analyze and Interpret Answers

1. Apples: New Zealand
Onions: United Kingdom
Tomatoes: Spain
Lamb: New Zealand

2. The difference would be accounted for by the need for artificial environments such as greenhouses and heat lamps to grow produce in cooler climates.

Conclude and Communicate

3. Advocates need to consider the cost (in energy) of growing certain types of produce in European climates. Closer does not mean better, even when transportation emissions are added in. Advocates would need to know that it is not just where the food is grown, but also whether it is a native plant that is adapted to grow in the local climate.

Extend Your Inquiry and Research Skills

4. Students answers' will vary, but might include what types of pesticides and technology were used to grow the food, whether agriculture directly supports the local economy (supporting local farmers even if their emissions are a bit higher), and the nutritional value of the food.