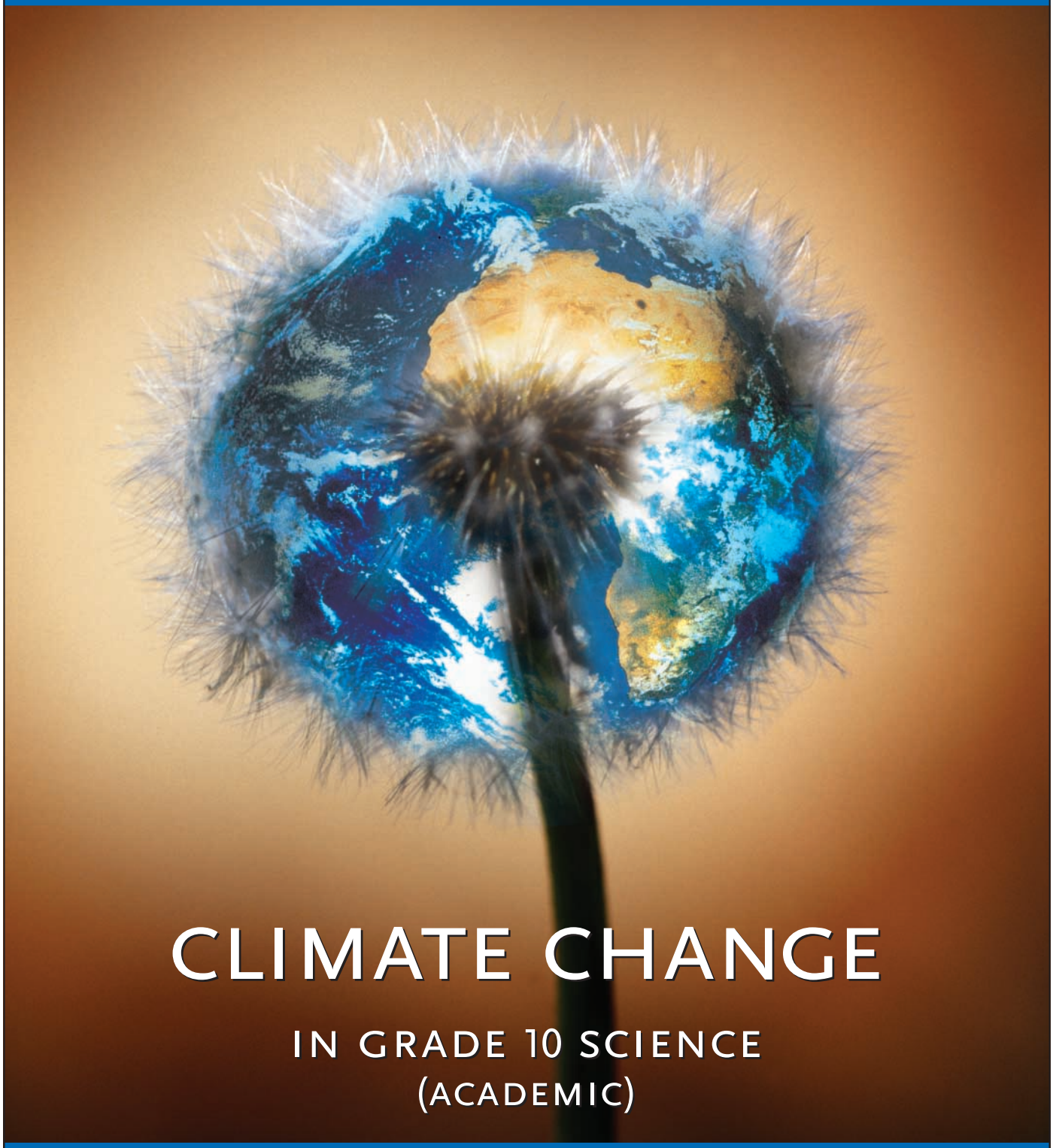
Ontario

ecological
LITERACY
GUIDE



CLIMATE CHANGE

IN GRADE 10 SCIENCE (ACADEMIC)

ecoschools

Acknowledgements
The Government of Canada's Climate Change Action Fund provided major funding for Ontario EcoSchools. Please see back cover for more information on all of the partners involved in the development of the program.

Ontario EcoSchools: Climate Change in Grade 10 Science (Academic)

Developer: Leesa Blake, Toronto District School Board
Reviewers: Chantal Garnett, York Catholic DSB; Janet Dignem, Durham DSB;
Lewis Molot, Faculty of Environmental Studies, York University
Editor: Eleanor Dudar, Toronto District School Board

Designer: Comet art + design

Science and EcoSchools

Climate Change in Grade 10 Science is one in the series of Ecological Literacy guides that make up the classroom component of EcoSchools. These guides offer teachers a new lens for seeing the environmental learning possibilities in the Ontario curriculum.

This resource is supported by *The Science of Climate Change*, a multimedia presentation that has been developed specifically to complement the Grade 10 Science curriculum. The multimedia presentation is available on CD; please see **www.yorku.ca/fes/envedu/ecoschools.asp** for ordering information.

Included in this resource are Big Ideas about climate change, Focus Questions, a choice of two culminating tasks and an annotated bibliography. Together, these materials provide a wealth of ideas that teachers can draw on in all areas of their program. These resources foster an approach that links knowledge to choices that lead to a more sustainable way of life.

Ontario EcoSchools Science resources have been developed to improve science and ecological literacy about one of the most important global issues facing us. These resources strive to educate students so that they will understand the science of climate change. This knowledge will be essential so that, as citizens, they can be part of the debate as government and industry respond to the challenges and opportunities that a changing climate will bring.

GUIDES FOR GETTING STARTED

1 *Introduction to EcoSchools and the Five-Step Process*

This concise guide provides an overview of the Ontario EcoSchools program and sets out a practical method for successful implementation: (1) establish an EcoTeam, (2) assess the school's needs, (3) identify priorities and develop an action plan, (4) implement the action plan, and (5) monitor and evaluate progress.

2 *Waste Minimization Guide*

This guide outlines the 10 Ontario EcoSchools waste minimization guidelines. It provides the school's EcoTeam with tips for assessing the school's current waste minimization efforts, sample reviews and action plans and a set of tools for implementing improved waste minimization practices.

3 *Energy Conservation Guide*

Similar in format to the *Waste Minimization Guide*, this resource outlines the 10 Ontario EcoSchools energy conservation guidelines. It provides the school's EcoTeam with tips for assessing the school's current energy conservation efforts, sample reviews and action plans and a set of tools for implementing improved energy conservation practices.

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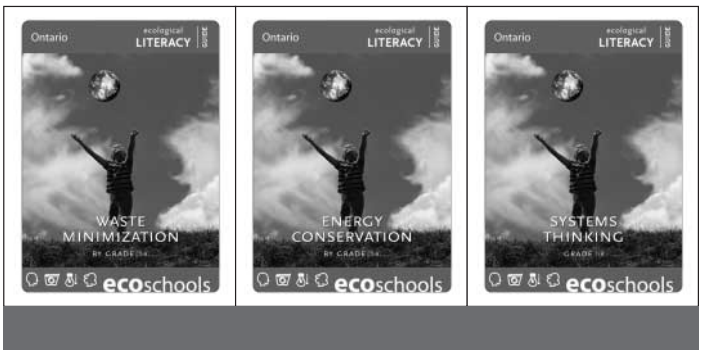

4 *Waste Minimization by Grade (1-8)*

This resource is organized around "big ideas" about waste and waste minimization that are based on identified clusters of learning expectations in both Science and Technology and Social Studies and Geography. Using these ideas as a focus helps the teacher incorporate ecological thinking into existing curriculum. Annotated Internet resources offer background facts and student learning activities.

5 *Energy Conservation by Grade (1-8)*

Like *Waste Minimization by Grade*, this guide is organized around "big ideas" about energy and energy conservation that are based on identified clusters of learning expectations in both Science and Technology and Social Studies and Geography. Using these ideas as a focus helps the teacher incorporate ecological thinking into existing curriculum. Annotated Internet resources offer background facts and student learning activities.

6 *Systems Thinking: Grades 1-8*

This resource helps shift our view of the nature of the human and natural worlds: instead of being collections of separate parts, they are seen as whole systems greater than the sum of their *interdependent* parts. Seeing the curriculum through a Systems Thinking lens highlights how the *interconnections* among learning expectations bestow the power of describing how the world works – seeing people in relation to the environment. This approach integrates diverse learning expectations into coherent clusters. Available in 2005.

CONNECTING ECOSCHOOLS TO THE ELEMENTARY CURRICULUM

CONNECTING ECOSCHOOLS TO THE SECONDARY CURRICULUM

7 *Climate Change in Grade 9 Geography (Academic and Applied)*

This resource consists of a culminating task for summative evaluation plus a unit-by-unit breakdown of the conceptual understandings about climate change needed to ensure student success. Students select a Canadian town or small city and develop an annotated map that indicates the changes in the human and natural environments that would reduce greenhouse gases and thus slow climate change. Resource list, student worksheets and evaluation rubric are provided. See #17 for supporting multimedia presentations.

8 *Climate Change in Grade 10 Civics*

This unit introduces students to the concept of citizenship through a series of well-supported activities where they analyze the accomplishments of environmental activists and organizations. A simple Public Policy Primer helps students see points at which they can influence issues. Students apply their knowledge in responding to the Government of Canada's One-Tonne Challenge for reducing climate change gases. An Environmental Citizenship Portfolio containing each student's class work and other materials sums up her/his understanding of environmental citizenship. See #17 for supporting multimedia presentations.

9 *Climate Change in Grade 10 Science (Academic and Applied)*

This resource provides two possible culminating tasks: students are introduced to an actual problem and asked to propose solutions to either The Impact of Transportation Choices or Forest Management and Climate Change. Climate change related concepts have been identified in each strand. Charts link authorized texts and the Teacher Resource for each to relevant learning expectations. A student Checklist of Preparation, annotated Internet resources and evaluation rubrics are also provided. See #17 for supporting multimedia presentations.

7 8 9 10 11 12

10 *Climate Change in Grade 11 and 12 Science*

This resource ranges over 8 different Science courses (University, University/College, College and Workplace), highlighting learning expectations that can be met using climate change issues as the examples. Focus questions help students connect the learning of facts and concepts in a meaningful way. The questions also suggest ways to adapt the existing curriculum to explore the data, evidence, interactions and technologies related to climate change issues. Lists of resources that suit the needs of the courses are included. See #17 for supporting multimedia presentations.

11 *Climate Change in Grade 11 and 12 Geography*

This resource surveys 5 Geography courses (University, University/College, and Open). Overall and specific expectations for each course are accompanied by guiding ideas linking these expectations to different parts of the climate change story. Examples are provided for developing topics, and teaching and learning strategies recommended for different student needs. Resources for planning class activities and assignments are listed. See #17 for supporting multimedia presentations.

12 *Interdisciplinary Studies: Climate Change and Your Future - Grade 12 (Open)*

This single-credit course reviews the impacts of climate change on human and natural systems. Students investigate local businesses and agencies to learn about environmental practices that reduce the impact of climate change. Through case studies, students identify emerging work opportunities; in the culminating task students develop a business plan related to mitigating or adapting to climate change. See #17 for supporting multimedia presentations.
Available in 2005.

GUIDES TO ENRICH YOUR PROGRAM

13 *Schoolground Greening: Designing for Shade and Energy Conservation*

Based on a guide developed by Evergreen and the Toronto District School Board, this resource will help schools design for increased shade to protect students and staff from ultraviolet radiation (UVR) and to shade school buildings to save energy and make them more comfortable. Tips for involving the school community in the design process, surveying user needs, completing a site analysis, creating site plans and developing a fundraising strategy are included.

14 *Celebrating EcoSchools: Festival Guide (Elementary)*

This collection of learning activities for elementary schools is designed for Earth Week or another EcoSchools celebration. While each activity can stand alone, the collection is especially designed for an entire school to engage in environmental learning adventures, focussing on the theme of human-environment connections. Based on a resource developed by the City of Toronto and the Toronto District School Board.

15 *The 20/20 Planner*

Based on a Toronto Public Health resource, *20/20 The Way to Clean Air* offers teachers a way to help students apply their learning about energy conservation at home. The planner is a "take-home" guide filled with simple tips and activity sheets that offer a range of actions that students and their families can undertake to reduce energy and vehicle use by 20% and respond to the Government of Canada's One-Tonne Challenge.

16 *Certification Guide*

The *Certification Guide* is based on a resource developed by the Clean Air Partnership and the Toronto District School Board. It provides sample benchmarks and a scoring system for schools wishing to assess their environmental performance in a limited number of areas. The point system establishes Bronze, Silver and Gold levels of EcoSchools. How participating schools are recognized is left to individual Boards to decide.

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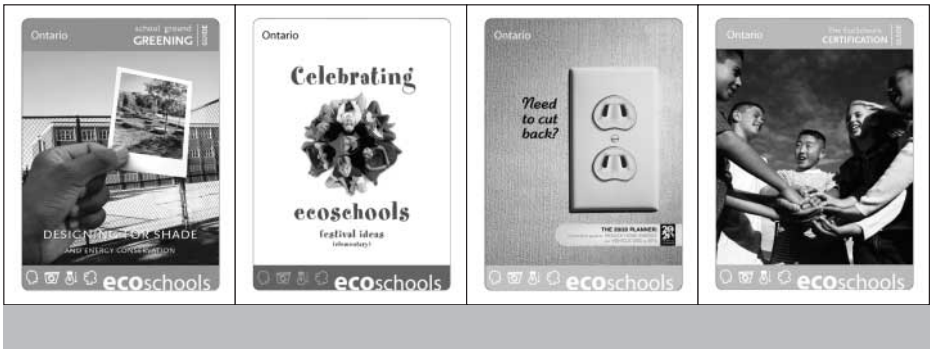

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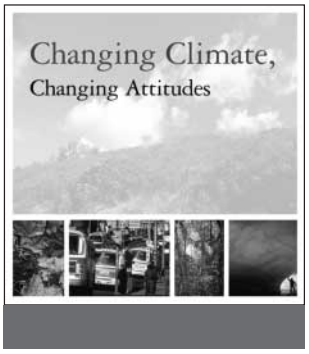


Free copies of all Ontario EcoSchools guides may be downloaded in PDF format. Go to www.yorku.ca/fes/envedu/ecoschools.asp

The three multimedia presentations are available only on the *EcoSchools Resources for Ontario Schools* CD (both PC and Mac-compatible). This CD also includes the Ontario EcoSchools guides and curriculum resources and is available for the cost of shipping and handling.
For ordering information, please contact:

Library and Learning Resources
Toronto District School Board
Tel: 416-397-2595 Fax: 416-395-8357
Email: curriculumdocs@tdsb.on.ca

17 Multimedia presentations: *Changing Climate, Changing Attitudes; The Impacts of Climate Change; The Science of Climate Change*

Three multimedia presentations have been designed to accompany the EcoSchools curriculum resources. *Changing Climate, Changing Attitudes* provides students and teachers with a general overview of global climate change and its impacts on Ontario society. *The Impacts of Climate Change* has been developed explicitly to complement the Grade 9 Geography course but can be used with all secondary students to examine the impacts of climate change on the natural and human worlds. *The Science of Climate Change*, while developed to support the Grade 10 Science course, is suitable for all secondary science students. These presentations include potential solutions and steps that citizens can take to help slow climate change.

MULTIMEDIA PRESENTATIONS TO ANCHOR YOUR PROGRAM

ecological
LITERACY | GUIDE

Climate Change in
Grade 10 Science
(Academic)

Contents

Ecological *inquiry* reveals our dependence on the healthy functioning of the earth's living systems which give us clean air, water, soil, food, and all the other resources we depend on. As our understanding of the inter-relatedness of all life increases, we can become literate in the ways to care for the earth that consider the wellbeing of future generations. Ecological *literacy* allows us to understand the urgency of developing protective, sustainable, and restorative relationships with the natural systems that are affected by our daily activities.

CLIMATE CHANGE AND GRADE 10 SCIENCE (ACADEMIC)

Several of the main concepts of Grade 10 Science (Academic) can be linked to understanding the phenomenon of climate change. Through science we understand how greenhouse gases are formed and how they contribute to changing levels of carbon dioxide in the atmosphere. As students explore the chemical reactions that contribute to climate change, they identify the factors that disrupt ecological balances within local and global ecosystems. Atmospheric carbon changes the way energy is retained on Earth, changing the motion of global wind and ocean current patterns.

In this resource, students use science to assess the environmental impact of either urban sprawl or contemporary logging practices. The purpose of each culminating task is to have students suggest alternatives that will mitigate greenhouse gas emissions.

Resource Overview

This resource outlines how a series of Big Ideas about climate change can illuminate some of the main concepts in Grade 10 Science. Two culminating tasks are provided: *A Case Study of the Environmental Impact of Transportation Choices* and *Forestry Management and Climate Change*. These tasks give students an opportunity to integrate their learning and apply their knowledge to situations where they are asked to explore ways to reduce greenhouse gas emissions.

This resource includes:

- **Big Ideas** about concepts that underlie the science of climate change;
- **Prior learning** – both fundamental skills and science background – required to complete the tasks;
- **Focus Questions** related to the Big Ideas in each of the strands which suggest ways to organize ideas as you plan your lessons with the culminating task in mind;
- **Culminating tasks** to help students explore how our individual and collective actions affect the earth's ecosystems and climate;
- A chart that shows how approved **textbooks and blackline masters** support learning about climate change;
- An **annotated list of websites** that accompanies each task.

UNDERSTANDING CLIMATE CHANGE: BIG IDEAS

The big ideas identify some of the concepts underlying climate change science and create a context for the culminating tasks:

- the flow of energy on the planet;
- the role carbon compounds play in changing the flow of energy;
- the choices that we can make to reduce the impact of carbon compounds on the flow of energy.

To understand these big ideas, several concepts are used to illustrate processes on Earth:

- the global carbon budget;
- the global radiation balance;
- "green" technologies that reduce CO_2 emissions.

The carbon budget consists of *sources* of gaseous carbon emissions and *sinks* where carbon is sequestered from the atmosphere. Within a natural ecosystem, there are many sources and sinks. Some human activities (e.g., fossil fuel based industries, transportation) are sources of carbon emissions while others (e.g., logging, filling in wetlands) destroy or impair the action of carbon sinks.

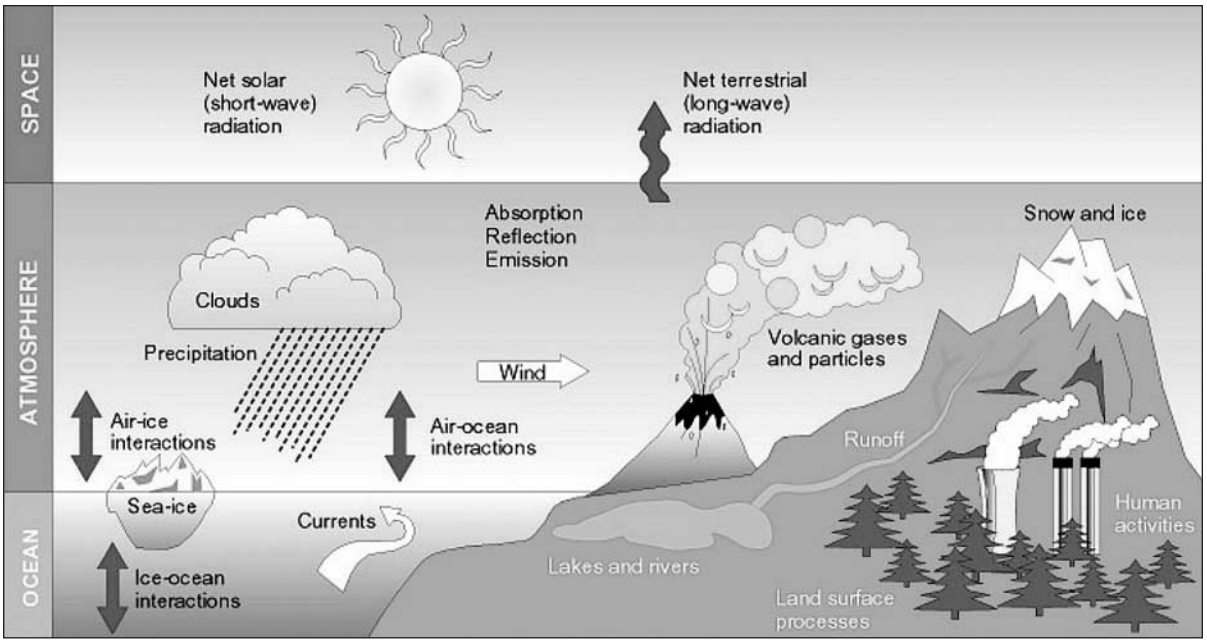
Energy from the sun drives Earth's weather and climate. This energy eventually leaves the Earth as heat. Certain atmospheric compounds, such as CO_2, absorb this energy and retain it in the atmosphere. This creates an imbalance, where less energy is released from the Earth than absorbed. New solar radiation continues to arrive on Earth, and the resulting energy imbalance affects global climate patterns.

Connecting CO_2 production to energy flow in the atmosphere and hydrosphere provides students with an understanding of how small changes in the concentration of CO_2 in the atmosphere can have significant consequences. Although weather variation is common in a local area, climate change creates greater potential risks. Climate change can have long-lasting effects on different economic sectors, such as forestry, tourism and agriculture.

Throughout this course, *CO_2 production is linked to changes in energy flow within the planet and the choices we make as individuals and as nations*. Heat transfer that affects the patterns of trade winds and ocean currents can lead to extreme changes in climate on the planet.

All of the big ideas presented link to choices. Choice and action help make the concept of climate change more relevant and meaningful to the adolescent student. In the culminating task, the students use research and analysis to apply what they have learned in the course to a plan of action in a specific context.

UNDERSTANDING THE CLIMATE SYSTEM



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Global Warming or Climate Change?

The terms global warming and climate change are often used interchangeably. What's the difference? Scientists' initial focus on the changing climate was the persistent temperature rise over several decades: hence "warming" was the feature that received major attention. The more comprehensive term "climate change" is more common now; it includes the global warming trend, but also refers to other climate change linked phenomena such as severe weather, melting polar ice caps, and high winds.

A special multimedia resource, *The Science of Climate Change*, has been developed specifically to complement the Grade 10 Science course. For ordering information, see the back cover of this resource.

CULMINATING TASKS

Two culminating tasks are outlined in the pages that follow; each is designed to be part of the 30% summative evaluation. Students will need 10 to 15 hours to complete the assigned task. Although no specific weight is attached to either task, the suggested value of this task is 10% of the final grade. Expectations from all four strands are included, but not equally distributed.

According to the practice at your school, distribute the Checklist of Preparation (Appendix 1.1 or 2.1) at or near the beginning of the course or toward its conclusion. If you do not distribute the task itself early in the course, you may want to describe in general terms what the final assignment will be. As students work through the course of study, remind them to use the Checklist periodically to track the key ideas and skills they are acquiring in readiness for the culminating task. Where possible, provide students with assessment opportunities to practice the skills needed, such as completing a report, assessing costs and benefits and proposing courses of action for change.

Focus Questions for each strand have been written to suggest ways to organize ideas and lessons to support the culminating task.

Task 1. A Case Study of the Environmental Impacts of Transportation Choices

Background: Solid waste (garbage) is often stored in landfill sites or incinerated. With the closure of the local landfill, Toronto's garbage is transported by truck to Michigan. Trucks transport solid waste from Toronto to Michigan, driving along Highway 401, traveling through areas with sensitive ecosystems or different land uses. People living near these areas are concerned about how this transportation choice affects them.

Scenario: Various people (farmer, transport company employee, reporter, municipal councillor, environmental activist) in the Toronto area have been asked to create a proposal that will reduce the environmental impacts of transporting waste.

Student Task: Students will complete an Environmental Impact Form. Then, students will choose (or be assigned) one of the following roles: farmer, transport company employee, reporter, municipal councillor, environmental activist. Using this assumed perspective, they will recommend a proposal for action for a strategy to reduce the environmental impacts of transporting waste. They will create a flyer to act as a cover page that could be sent to members of city council, lobbying for a strategy that will:

- support their position;
- describe the effects on a specific ecosystem;
- describe the effects on the global climate and support the goal of the Kyoto Protocol to reduce greenhouse gas emissions.

Resources

Student worksheets have been developed to support this task:

- Appendix 1.1 *Checklist of Preparation - A Case Study of the Impact of Transportation Choices* helps the students keep track of the information and skills they need to prepare for the assignment.
- Appendix 1.2 *Summary of the Kyoto Protocol* provides an overview of the Protocol and its goals.
- Appendix 1.3 *Student Task: A Case Study of the Impact of Transportation Choices* outlines the task and identifies the expectations covered.
- Appendix 1.4 *Environmental Impact Form* organizes the students' work to help ensure that they have all the information necessary to complete the task.

Teacher resources include:

- Strand-by-strand Focus Questions are supplied to help organize ideas and lessons to support the task.
- Appendix 1.5 *Evaluation Rubric for Environmental Impact Form*
- Appendix 1.6 *Evaluation Rubric for Flyer*

Expectations

[Note: examples in square brackets are additions tailored for this resource.]

BY1.05D examine how abiotic factors affect the survival and geographical location of biotic communities

BY3.01D assess the impact of technological change and natural change on an ecosystem

BY3.05D identify and evaluate Canadian initiatives in protecting Canada's ecosystems [e.g., Kyoto, MNR]

CH1.04D describe and explain qualitatively how factors such as energy, concentration, and surface area can affect rates of chemical reactions

CH2.08D represent simple chemical reactions using molecular models, word equations, and balanced chemical equations (to show how new compounds are formed)

CH3.01D explain how environmental challenges can be addressed through an understanding of chemical substances [e.g., reducing the production of CO_2 using effective technologies]

ES1.02D describe and explain heat transfer within the water cycle and how the hydrosphere and atmosphere act as heat sinks [how do changes in local heat production affect local weather through the water cycle]

ES1.03D describe and explain heat transfer in the hydrosphere and atmosphere and its effects on air and water currents

ES2.06D investigate factors which affect the development, severity, and movement of global and local weather systems [Are global systems causing changes? What are predicted rates?]

PHV.03D analyse everyday phenomena and technologies in terms of the motions involved [e.g., consider alternate transport systems]

BY2.03D select and integrate information from various sources, including electronic and print resources, community resources, and personally collected data, to answer the questions chosen

BY2.04D analyse data and information and evaluate evidence and sources of information, identifying flaws such as errors and bias

PH3.03D analyse how technology is used for tracking the motion of objects and outline the kinds of scientific knowledge gained through the use of such technologies

Prior Learning Required for this Task

The task requires that the student have a basic understanding of one of the main goals of the Kyoto Protocol which Canada has ratified – to reduce greenhouse gas emissions (to 6% below 1990 levels by the 2008-2012 period). This is the context within which the research, analysis and application is pursued. See Appendix 1.2 for a one-page student summary of the Kyoto Protocol

The Ontario EcoSchools multimedia presentation The Science of Climate Change has been designed specifically for Grade 10 Science (see Resources for ordering information).

Fundamental Skills

- ***Read and Analyse***

Students need to be able to read material and identify/classify key ideas:

Problem
Processes
Factors
Effects

Concept mapping activities or other graphic organizers that help them find and classify information would provide practice.

- ***Research***

Students need to be able to find information on the ecosystem of interest. This may include map-reading skills. From this material, students need to identify biotic and abiotic factors. Activities that support this learning require students to find data and interpret data. *As students learn about ecosystems they should work with the same text and electronic resources that will be available for the summative task.*

- ***Systems Analysis***

Students need to be able to identify parts of a system and connections between or among systems. In particular, students need to be able to identify relevant outputs from human systems that act as inputs into one or more other (natural or social) systems.

Science Background

- ***Biology: The Sustainability of Ecosystems***

Textbooks often present a generic ecosystem for describing the parts and processes of such a system. Students need to identify specific elements in a specific ecosystem to complete the summative task effectively.

- ***Chemistry: Chemical Processes***

Truck exhaust is a source of heat, acid and GHG. The diversity of these emissions must be addressed during the learning of the course so that they can apply this knowledge to the summative task. Students may want to find out how many trucks leave the city each day and what the specific output of each truck is.

- ***Earth and Space Science: Weather Dynamics***

Textbooks often present generic weather information. Students need to be familiar with how to find normal weather patterns for a region that contains an ecosystem of interest. This means that they need to consider the abiotic factors of an ecosystem in terms of weather events, such as rain, flood, drought, snow, ice, etc.

- ***Physics: Motion***

Students must have some experience working with maps that describe transportation routes. This should include interpreting how many lanes wide a highway is at different stretches, and any differences in maximum speed. Ideally, students will have some experience comparing the effectiveness of different transportation systems such as gas-powered trucks, diesel trucks and trains.

Focus Questions – Connections to Climate Change

These strand-by-strand questions are provided to suggest ways to organize ideas as you plan your lessons with the culminating task in mind.

Biology: The Sustainability of Ecosystems

Focus Questions

How is the carbon cycle related to climate change?
What are the consequences of changing the carbon balance?
How does the production of CO_2 affect the carbon cycle?
How does CO_2 change the amount of heat in the atmosphere?
How does increased heat affect the carbon cycle?
How much CO_2 makes a difference?
What are the consequences of CO_2 changes for ecosystems?
How is pH linked to changes in the atmosphere and ecosystems?
How can production of CO_2 be measured?
What new technologies can monitor and reduce carbon production?
What kinds of transportation would help meet the targets of the Kyoto Protocol?
How do governments in Canada support sustainable practices?

Climate Change Connections

- Any model of the carbon cycle for an ecosystem can act as a model for a carbon budget for the planet. This accounting framework measures carbon stocks and fluxes (inputs and outputs) that identify carbon sources and sinks. A balance of sources and sinks means that global levels remain the same. Activity that disturbs this balance can then be identified.
- Heat is an important abiotic factor that helps relate the specific details of an ecosystem to the macrocosm of the planet. Increased energy in the atmosphere affects both wind and water patterns, which in turn affect weather and climate patterns.
- Explicitly consider the Kyoto Protocol in terms of technology use and development. Canadian initiatives include technology development, especially the development of "green" technology that has a small ecological footprint, and a system of national parks that protects ecosystems. Government policy and support for "green" technology and national parks can be explored and assessed.
- The belief in the need for sustainable activity underlies some policy choices and technological innovation. As more people are affected by the consequences of change, they begin to understand the need for more sustainable practices.

Chemistry: Chemical Processes

Focus Questions

What are some of the chemical products of some human processes such as incineration or vehicle emission?
How can the products of one chemical reaction affect the reactions of other substances in the environment?
What are some of the greenhouse gases (GHGs)?
How do GHGs affect the environment?
How do we assess the environmental impact of a chemical process?
How is the chemical nature of the atmosphere changed with the addition of some of the wastes of human processes?
What is the impact of different concentrations of substances on the environment and other chemical reactions?
How can CO_2 be detected or measured?
How can the products of chemical processes be reused or recovered to limit their impact on the environment?

Climate Change Connections

- Many industrial and technological processes have a chemical impact on the environment. Reactions of interest should include combustion of carbon compounds to form greenhouse gases, and the products of oxidized metal, which can result from increased air pollution.
- The concentration of greenhouse gases changes the impact of these gases on ecosystems and global climate patterns.
- Use specific greenhouse gases and other carbon compounds to reinforce students' understanding of the different components of the carbon cycle.
- Simple chemical formulae help explain the changes that take place in the small system of a chemical reaction. The products may then participate with other substances, including substances in the surrounding environment.
- Products formed by the combustion of organic compounds such as oil, wood or natural gas are released into the environment.
- Carbon dioxide is the product of many reactions. Finding a test to determine the presence of carbon dioxide has allowed us to monitor the level of these emissions in the atmosphere. This is an example of why it is important to be able to assess the impact of chemical processes on the environment.
- Strategies to reduce emissions already exist that involve the addition of new parts (catalytic converter on cars or scrubbers on industrial smokestacks) to a system to change the output to the environment.
- Different "green" products or choices can be explored. Sometimes products are "green" because an output (water bottle) is added to a new system that cycles the matter (as fleece clothing). Other products are "green" because they are produced through efficient energy means and/or use energy more efficiently.

Earth and Space Science: Weather Dynamics

Focus Questions

What is the global radiation balance?

How does CO_2 concentration in the atmosphere affect the global radiation balance?

What is the flow of energy in the atmosphere and hydrosphere?

How does human activity affect the global radiation balance?

How do changes to the global radiation balance affect us?

What are the potential consequences for climate change?

Climate Change Connections

- Explain the global radiation balance in terms of energy arriving from the sun and energy leaving the planet to outer space. Then consider how changes to the atmosphere caused by greenhouse gases affect this balance of incoming and outgoing energy. The greenhouse gases absorb outgoing radiation, so less energy leaves the Earth. The solar radiation arriving is almost constant, so the imbalance increases and high levels of energy are retained.
- With a net change of more energy in the atmosphere, the transfer of energy changes, affecting both trade wind patterns and ocean current patterns. Climate change is a consequence of these energy changes.
- Heat transfer is studied in terms of changes in the hydrosphere. This is where heat transfer takes place and where the consequences develop.
- Consider the consequences of shifting wind patterns and current patterns. This is like climate modeling, and allows students to consider possible future scenarios.

Physics: Motion

Focus Questions

How can transportation systems be defined?

What is the environmental impact of different transportation systems?

Why are some transportation systems preferred over other systems?

Climate Change Connections

- Transportation systems can be defined and compared in terms of energy use and CO_2 production. Compare the stopping and starting of different forms of transportation along a specific path (such as Keele station to Yonge station along Bloor Street).

  A subway train will start and stop fewer times than an automobile.
- Fast, flexible transportation has generally required fossil fuels. Cars allow more personal freedom than a train can provide (train may be electric or diesel).

Resources

Textbooks

See "How Approved Textbooks Link to Learning about Climate Change" (pages 39-42) for a strand-by-strand list of climate change topics in Science textbooks.

Websites

Carbon budget

http://www.climatechangesolutions.com/science/greenhouse/budget.shtml?o=gases&r=budget

Simple explanation of model with sample values. "One of the easiest ways to understand how and why human activities are changing the global climate is to think of the earth's atmosphere as a credit card account. The annual statement lists purchases and repayments, and the difference between the two is the increase in the total debt. In the case of carbon dioxide, which is the most important long-lived greenhouse gas (GHG), the statement is referred to as a carbon budget. The purchases made are called emissions, and the repayments made are called 'sinks'"

http://geochange.er.usgs.gov/pub/carbon/fs97137/

This is a very helpful site that puts the idea of the carbon budget in the climate change context, with specific reference to the Mississippi Valley.

Ecosystems

http://www.ec.gc.ca/ecos_e.html

This site from Environment Canada has information about ecosystems across Canada, and in the Great Lakes region.

http://www.climatehotmap.org/impacts/greatlakes.html

This is an American site that looks at how human activity has compromised, and continues to compromise, the Great Lakes region.

http://www.ucsusa.org/greatlakes/

This excellent site from the Union of Concerned Scientists has links to many PDF files. The focus is to link climate change to ecosystems in the area with an overall view of climate models, extreme weather and actions we can choose.

http://www.epa.gov/glnpo/ecopage/

This site has many links that are useful for ecosystem studies.

Vehicle Exhaust

http://www.lungusa.org/air/airout00_diesel.html

This site is simple and points out that diesel exhaust includes many different compounds that affect human health.

http://www.osha.gov/SLTC/dieselexhaust/chemical.html
A good list that includes many components of diesel exhaust. Each chemical listed links to a chemical sampling information page.

http://www.planetdrum.org/guard_fox_watch.htm
A site devoted to finding sustainable solutions by developing bioregional activities. This page looks at the environmental impact of transportation routes and vehicular traffic in an environmentally sensitive area (The Winter Olympics in Nagano).

http://www.nutramed.com/environment/carschemicals.htm
There are many links on this site. This site identifies health risks from exhaust chemicals.

http://www.nrdc.org/air/transportation/ebd/chap2.asp
Good site with health risks outlined and specific chemical products listed.

Weather

http://www.ec.gc.ca/TKEI/cc_weather/s_weather_e.cfm
This site explains what is meant by "severe weather" and uses Canadian examples as illustrations.

http://www.epa.gov/glnpo/atlas/glat-ch2.html
Some basic information about climate in the Great Lakes region.

http://www.ucsusa.org/greatlakes/pdf/temperature.pdf
More detailed look at the impact of climate change on the Great Lakes region.

http://www.great-lakes.net/envt/refs/weather.html
A site that provides weather information for local areas.

Transportation

http://www.vtpi.org/tca/tca0514.pdf
Chapter 14 of the Victoria Transport Policy Institute's *Transportation Costs and Benefits Analysis* guide focuses on "Land Use Impacts." It provides a comprehensive and detailed account that may be helpful background information for the teacher wanting to have a more detailed understanding of the connections between urban sprawl and transportation modes. In particular, the "Environmental Degradation" section (pages 5 - 8) in this chapter bears very directly on the culminating task outlined above.

http://www.niwa.cri.nz/ncces/co2calc/
This New Zealand Residential CO_2 Calculator site allows students to calculate the amount of CO_2 produced by cars using gas or diesel, when distance (in km) is used.

http://www.ene.gov.on.ca/cons/371706.htm
Ontario's Drive Clean Program site.

http://www.eia.doe.gov/oiaf/1605/gg96rpt/chap2.html
This site shows that CO_2 emissions from transportation produces about one-third of USA carbon emissions.

Other Sites

http://www.ekes.org/climate/individaction.html
Individuals taking action to help the environment.

http://climatechange.sea.ca/climate_change.html
An overview of climate change – brief history, the debate, the greenhouse effect, the causes/sources, implications of temperature rise and the Kyoto protocol.

Appendix 1.1 *Checklist of Preparation - A Case Study of the Environmental Impacts of Transportation Choices*

As you work through the course of study, remember to use the checklist periodically to track the key ideas and skills you are acquiring as you prepare for the final assignment.

Checklist of Preparation

I can

- ☐ identify biotic and abiotic factors in an ecosystem
- ☐ research information about an ecosystem
- ☐ find and interpret data about ecosystems
- ☐ ask questions about the impact of chemical processes on the environment
- ☐ identify chemical products of vehicle exhaust
- ☐ compare the exhaust production of different fuels (gas, diesel, electric, hydrogen)
- ☐ describe the flow of water (run-off, precipitation) for a specific area
- ☐ describe extreme weather events for a specific area
- ☐ find and analyse different transportation routes
- ☐ assess the environmental impact of different methods of transportation

Appendix 1.2 *Summary of the Kyoto Protocol*

Countries around the world have recognized that climate change affects us all. The volume of greenhouse gases produced by human activity, added to the gases occurring naturally in the atmosphere, has led to extreme weather events, temperature changes and the melting of the Arctic icecaps.

In December 1997, Canada and more than 160 other countries met in Kyoto, Japan, and agreed to targets to reduce greenhouse gas emissions. The agreement that set out those targets, and the options available to countries to achieve them, is known as the Kyoto Protocol. Canada's target is to reduce its greenhouse gas (GHG) emissions to 6 percent below 1990 levels by the period between 2008 and 2012. The goal of Kyoto is to reduce the total emissions of industrialized countries to 5.2% below 1990 levels.

The Government of Canada and the provincial/territorial and municipal governments are working together to achieve reductions in greenhouse gases. Investment in new technologies will help business to operate in a more efficient way and Canadians will benefit by having a cleaner environment. The Kyoto Protocol allows the presence of carbon sinks to count toward a country's commitment to reduce greenhouse gases. A "sink" is any process that removes greenhouse gases from the atmosphere. For example, forests form a carbon "sink" through the process of photosynthesis – trees and other plants take up carbon dioxide (CO_2) and break it down. The oxygen (O_2) is released and the carbon (C) becomes part of the tree.

The Kyoto Protocol allows countries to buy carbon credits from other countries. This means that countries that reduce their greenhouse gas emissions by more than is required under Kyoto can sell their unused carbon credits to countries that find it difficult or expensive to reduce emissions[1]. This is called emissions-reduction trading. In other words, countries that have "overperformed" (met and exceeded their target for reduction) may sell their "unused right to pollute" to countries that have failed to meet their emissions reduction target. Canada believes that a solution that uses the market has a part to play in achieving an overall reduction of greenhouse gases globally.

It is important that countries that have signed the Kyoto Protocol comply with the rules. To that end, Canada is working to build an effective way to measure whether everyone is doing their part. This is a way of checking that countries obey the rules agreed upon, giving them strong incentives to take their commitments seriously.

Based in part on information found at www.climatechange.gc.ca.
For a glossary of terms, please see the Resources section at the end of this document.

[1] While it may appear strange that one country can buy the right to pollute from another country, remember that the total emissions of participating countries selling and buying carbon "credits" are to reach the agreed upon targets between 2008 and 2012. Some believe that countries being able to pay others in order to keep polluting is wrong; others say that it is a way of encouraging those who can to make greater reductions while penalizing those who don't.

Appendix 1.3 *Student Task and Expectations: A Case Study of the Environmental Impact of Transportation Choices*

Purpose: Assess the environmental impacts of different transportation choices and propose a transportation strategy to remove Toronto's garbage.

Background: Solid waste (garbage) is often stored in landfill sites or incinerated. With the closure of the local landfill, Toronto's garbage is transported by truck to Michigan. Trucks transport solid waste from Toronto to Michigan, driving along Highway 401, traveling through areas with sensitive ecosystems or different land uses. People living near these areas are concerned about how this transportation choice affects them.

Scenario: Various people (farmer, transport company employee, reporter, municipal councilor, environmental activist) in the Toronto area have been asked to create a proposal that will reduce the environmental impacts of transporting waste.

Assignment: Complete an Environmental Impact Form. Then, students will choose (or be assigned) one of the following roles: farmer, transport company employee, reporter, municipal councilor, environmental activist. Using this assumed perspective, propose a strategy to reduce the environmental impacts of transporting waste. Create a flyer to act as a cover page that could be sent to members of city council, lobbying for a strategy that will:

- support your position;
- describe the effects on a specific ecosystem;
- describe the effects on the global climate and
- support the goal of the Kyoto Protocol to reduce greenhouse gas emissions.

Expectations: Use this list of expectations, along with Appendix 1.1 *Checklist of Preparation* to help you complete your assignment.

- examine how abiotic factors affect the survival and geographical location of biotic communities [e.g., fresh water, soil composition, temperature]
- assess the impact of technological change and natural change on an ecosystem
- identify and evaluate Canadian initiatives in protecting Canada's ecosystems [e.g., Kyoto, National Parks]
- describe and explain qualitatively how factors such as energy, concentration, and surface area can affect rates of chemical reactions [and affect an ecosystem]
- name and write the formulae of common ionic and molecular compounds, using a periodic table and an IUPAC table of ions [for compounds now found in the ecosystem]
- represent simple chemical reactions using molecular models, word equations, and balanced chemical equations [to show how new compounds are formed]
- explain how environmental challenges can be addressed through an understanding of chemical substances [e.g., can adding new substances moderate the impact of pollutants?]
- describe and explain heat transfer within the water cycle and how the hydrosphere and atmosphere act as heat sinks [how do changes in local heat production affect local weather through the water cycle]

- describe and explain heat transfer in the hydrosphere and atmosphere and its effects on air and water currents
- investigate factors which affect the development, severity, and movement of global and local weather systems [What are the incidents of severe weather? Are global systems causing changes?]
- analyse everyday phenomena and technologies in terms of the motions involved [e.g., consider alternate transport systems]
- identify and evaluate Canadian initiatives in protecting Canada's ecosystems [such as the Kyoto Protocol]
- analyse how technology is used for tracking the motion of objects and outline the kinds of scientific knowledge gained through the use of such technologies
- select and integrate information from various sources, including electronic and print resources, community resources, and personally collected data, to answer the questions chosen
- analyse data and information and evaluate evidence and sources of information, identifying flaws such as errors and bias

Appendix 1.4 *Environmental Impact Form (1)*

PROBLEM: What activity do you think changes the environment?	
Ecosystem (Which ecosystem[s] is [are] affected by this activity?)	
What factors are changed by this human activity?	
Abiotic Factors	**Biotic Factors**
Human Activity [describe]	

Appendix 1.4 *Environmental Impact Form (2)*

Factors from this activity that affect the environment	
Relevant Chemical Reactions	Heat Generation
Movement or Transportation Issues	

Appendix 1.4 *Environmental Impact Form (3)*

Impact of Change on Ecosystem
Weather Systems Affected
Risk Related to this Activity
Attach relevant data or documents to this report

Appendix 1.5 *Evaluation Rubric for Environmental Impact Form*

Description	Level 1	Level 2	Level 3	Level 4
K/U Understanding of concepts	Concepts are simple, with gaps	Concepts are mostly simple and complete	Ideas are developed with some depth	Concepts are complete and developed with insight
K/U Facts and terms used accurately and connect to concepts presented	Facts and terms are presented with limited accuracy and loosely connect to the concepts presented	Facts and terms used accurately and appropriately for the concepts presented	Facts and terms are used accurately and they connect and support concepts presented	Facts and terms effectively support the ideas presented so that the concepts are understood more easily
I Analysis and interpretation of data	Limited analysis and interpretation of data	Moderate analysis and interpretation of data	Considerable analysis and interpretation of data	Thorough analysis and interpretation of data
C Accurate use of scientific terminology, symbols, conventions and SI units	Limited accuracy of scientific terminology, symbols, conventions and SI units	Moderate accuracy of scientific terminology, symbols, conventions, and SI units	Considerable accuracy of scientific terminology, symbols, conventions, and SI units	A high degree of accuracy of scientific terminology, symbols, conventions, and SI units
C Use of information technology for scientific purposes	Researches appropriately, using the given resources	Researches appropriately using the given resources and useful additional sites	Researches appropriately using the given resources and additional sites that are effective	Researches appropriately using given sites and a variety of additional sites that are highly effective
MC Assessment of impacts of science and technology on the environment	Identifies how an ecosystem is at risk as a result of a specific activity	Explains how an ecosystem at risk is affected as a result of a specific activity	Explains how an ecosystem can be affected by particular aspects of the specific activity	Explains the impact of different elements of the specific activity on particular aspects of an ecosystem

Appendix 1.6 *Evaluation Rubric for Flyer*

Description	Level 1	Level 2	Level 3	Level 4
K/U Understanding of concepts presented	Concepts presented are simple, with gaps	Concepts are mostly simple and complete	Concepts are developed with some depth	Concepts are complete and developed with insight
K/U Understanding of relationships between concepts	Concepts presented are simple, with gaps	Concepts presented show simple connections	Concepts have clear connections presented	Concept connections support and develop concepts thoroughly
C Communication of information and ideas	Information and ideas are vague and presented with doubt	Information and ideas are complicated or difficult to understand	Information and ideas are presented clearly and understandably	Information and ideas are presented simply, clearly and are easy to understand
C Communicates with a purpose for the given audience	Audience and purpose inconsistent	Audience and purpose consistent	Clear and consistent sense of audience and purpose	Strong, clear sense of audience and purpose
C Use of flyer form	Text and graphics show limited command of the flyer form	Text and graphics show moderate command of the flyer form	Text and graphics show considerable command of the flyer form	Text and graphics show extensive command of the flyer form
MC Proposing courses of practical action in response to problems identified	Extends analyses of problems into courses of practical action with limited effectiveness	Extends analyses of problems into courses of practical action with moderate effectiveness	Extends analyses of problems into courses of practical action with considerable effectiveness	Extends analyses of problems into courses of practical action with a high degree of effectiveness

Task 2. Forestry Management and Climate Change

Purpose: To outline and recommend good forestry strategies for a local forest to help maintain the carbon budget, reduce global climate change and support the Kyoto Protocol.

Scenario: A local forest provides timber for a pulp mill and softwood lumber for construction. The old growth forest was harvested in the 1800s, mostly for white pine. Spruce and balsam have been cut for pulp, but the construction boom in Southern Ontario has increased the value of logs that can be transported to that market for building construction. Local residents are concerned that cutting too much timber will reduce the value of the forest and hurt local ecosystems, which are also valuable for tourism. Some people are also concerned that increased cutting will contribute to climate change. The Ministry of Natural Resources requires that forest managers be certified for ISO 14001 Standards.

Several people in the area (environmental activist, forester, forest manager, municipal official) have been asked to outline and recommend good forestry practices that will help maintain the carbon budget, slow global climate change and help meet the goal of the Kyoto Protocol to reduce greenhouse gas emissions.

Student Task: Students will choose (or be assigned) one of the following roles: environmental activist, forester, forest manager, municipal official. Using this assumed perspective, they will complete a report that outlines how the practices they have described affect the value of the forest and the environment in terms of a specific ecosystem and the global climate.

The report is to explain how each choice connects to slowing climate change, thus helping to meet the goal of the Kyoto Protocol to reduce greenhouse gas emissions. A copy of rough work and a list of sources should be included to support the recommendations made. The report should answer the following questions:

a) What are good forestry practices?
b) How does the chosen method of harvesting and regrowth affect global climate?
c) How do these practices reduce the environmental impact on local ecosystems?

Resources:

Several student worksheets/ resources support the task:

- Appendix 2.1 *Checklist of Preparation-Forestry Management and Climate Change* helps the student keep track of the information and skills they need to prepare for the assignment;
- Appendix 1.2 *Summary of the Kyoto Protocol* (see page 18) to provide an overview of the Protocol and its goals;
- Appendix 2.2 *Student Task and Expectations-Forestry Management and Climate Change* outlines the task and identifies the expectations covered.

Teacher resources have been developed:

- Strand-by-strand Focus Questions to organize ideas and lessons to support the task;
- Appendix 2.3 *Evaluation Rubric for Report.*

Expectations

(Note: examples in square brackets are additions tailored for this resource.)

BY1.05D examine how abiotic factors affect the survival and geographical location of biotic communities

BY3.01D assess the impact of technological change and natural change on an ecosystem

BY3.05D identify and evaluate Canadian initiatives in protecting Canada's ecosystems [e.g., Kyoto, MNR and ISO 14001 for forestry management]

CH1.04D describe and explain qualitatively how factors such as energy, concentration, and surface area can affect rates of chemical reactions [and affect the frequency of forest fires]

CH2.08D represent simple chemical reactions using molecular models, word equations, and balanced chemical equations [to show how new compounds are formed]

CH3.01D explain how environmental challenges can be addressed through an understanding of chemical substances [e.g., reducing the production of CO_2 using effective technologies]

ES1.02D describe and explain heat transfer within the water cycle and how the hydrosphere and atmosphere act as heat sinks [how do changes in local heat production affect local weather through the water cycle]

ES1.03D describe and explain heat transfer in the hydrosphere and atmosphere and its effects on air and water currents

ES2.06D investigate factors which affect the development, severity, and movement of global and local weather systems [What are the incidents of forest fire? Are global systems causing changes? What are predicted rates?]

PHV.03D analyse everyday phenomena and technologies in terms of the motions involved [e.g., consider alternate transport systems]

BY2.03D select and integrate information from various sources, including electronic and print resources, community resources, and personally collected data, to answer the questions chosen

BY2.04D analyse data and information and evaluate evidence and sources of information, identifying flaws such as errors and bias

PH3.03D analyse how technology is used for tracking the motion of objects and outline the kinds of scientific knowledge gained through the use of such technologies

Prior Learning Required for this Task

The task requires that the student have a basic understanding of one of the main goals of the Kyoto Protocol which Canada has ratified – to reduce greenhouse gas emissions (to 6% below 1990 levels by the 2008-2012 period). This is the context within which the research, analysis and application is pursued. See Appendix 1.2 (page 18) for a one-page student summary of the Kyoto Protocol.

The Ontario EcoSchools multimedia presentation The Science of Climate Change *has been designed specifically for Grade 10 Science (see Resources for ordering information).*

Fundamental Skills

- ***Read and Analyse***

Students need to be able to read material and identify/classify key ideas:

Problem
Processes
Factors
Effects
Costs
Benefits

Concept mapping activities or other graphic organizers that help students find and classify information would provide practice.

- ***Research***

Students need to be able to find information on forest management practices. This may include map-reading skills. From this material, students need to identify how different strategies affect Canada's carbon budget and various ecosystems that are part of or near the forest. Activities that support this require students to find and interpret information. *As students learn about ecosystems in the Biology strand they should work with resources that will be available for this summative task.*

- ***Systems Analysis***

Students need to be able to identify parts of a system and connections between or among systems. In particular, students need to be able to identify human choices that act as inputs to the forest, affecting not only local ecosystems, but also the potential for future human activities in the area and the long-term yield of forest products.

Science Background

See "How Approved Textbooks Link to Learning about Climate Change" (pages 39-42) for an annotated list of topics.

- ***The Sustainability of EcoSystems***

Textbooks often present a generic ecosystem for describing the parts and processes of such a system. Students need to identify specific elements in a specific ecosystem to complete the summative task effectively. Succession to a climax forest provides an opportunity to discuss a number of different ecosystems that could be found near a managed forest. Student research and analysis of a specific ecosystem helps develop skills that will be required for this summative task.

- ***Chemistry: Chemical Process***

Using experiments they can do, or using research skills, students can identify chemical products of various combustion reactions, forest fires and vehicular combustion (gasoline and diesel). Combustion produces CO_2 and also ash that can affect local ecosystems.

- ***Earth and Space Science: Weather Dynamics***

Textbooks often present generic weather information. Students need to be familiar with how to find normal weather patterns for a region that contains an ecosystem of interest. Researching information about weather conditions that increase or decrease the risk of forest fires would be a useful practice for this summative task. Students can also use predictions of future climatic conditions to generalize about the future of forests in different parts of Canada, especially areas in the West.

- ***Physics: Motion***

Wood products can be transported in various ways, but trucks are used more frequently at all sites. This requires that roads be built into relatively remote areas. Truck exhaust is a source of heat, and many different chemical products. Students may want to find out how many trucks are required to carry enough logs to make the wood products in a community of single family dwellings. This data can then be used to make generalizations about how much forest is used and the amount of GHGs generated by transporting these products.

Focus Questions – Connections to Climate Change

These strand-by-strand questions are provided to suggest ways to organize ideas as you plan your lessons with the culminating task in mind.

Biology: The Sustainability of EcoSystems

Focus Questions

What are the sources and sinks for carbon in a forest and in the world?

What roles do forests play in the global carbon budget?

How does the role of a forest change as it ages or is cut for timber?

How do forest fires affect the carbon budget?

What is the impact of forest fires on an ecosystem?

How does ash affect an ecosystem?

How are different forests harvested?

What technological changes have affected cutting and removing timber from a forest?

What are the impacts of different forestry practices?

What is meant by "sustainable forestry"?

How do specific forestry practices link to climate change concerns outlined in the Kyoto Protocol?

Climate Change Connections

- Any model of the carbon cycle for an ecosystem can act as a model for a *carbon budget* for the planet. This accounting framework measures carbon stocks and fluxes (inputs and outputs) by identifying carbon sources and sinks. A balance of sources and sinks means that global levels remain the same. Activity that disturbs this balance can then be identified.
- Forests play a role in the carbon budget. As sinks, a growing forest sequesters CO_2 from the atmosphere. Harvesting forests reduces this activity, but can lead to renewed growth and hence renewed sequestering. Forest fires both deforest the environment and increase CO_2 levels in the atmosphere.
- Have students consider the role of diversity in an ecosystem. Look specifically at how changing forestry and transportation technologies can affect the ecosystem's ability to respond to stress, such as forest harvesting or fire. These considerations can then act as a foundation for a broader exploration of sustainability and practices that are consistent with sustainable forests. Link this discussion to the carbon budget model presented above for a better understanding of climate change issues and the goals of the Kyoto Protocol in relation to choices that people make.

Chemistry: Chemical Process

Focus Questions

What are the chemical reactions that make up a forest fire?

How do the products of a forest fire affect an ecosystem?

What are other chemical reactions that produce greenhouse gases?

What are other products of other combustion reactions that contribute greenhouse gases to the atmosphere?

What are other effects on the local environment?

Which forestry practices produce fewer greenhouse gases?

Climate Change Connections

- Forest fires are an example of combustion reactions that form greenhouse gases. Burning fuels for transportation or other technologies can produce greenhouse gases and acid compounds that affect ecosystems. As the concentration of greenhouse gases increases, the impact of these gases on ecosystems and global climate patterns is more severe. The chemistry learned here can be used for later learning about weather and climate patterns.
- Use specific greenhouse gases and other carbon compounds to reinforce students' understanding of the components of the carbon cycle.
- Making consumer choices with the environment in mind can be explored. Forestry methods that reduce CO_2 emissions are "green" *practices*. Goods produced through using energy and materials more efficiently are "green" *products*.
- Forestry methods can be ranked in terms of CO_2 output; some methods are "greener" than others.

Earth and Space Science: Weather Dynamics

Focus Questions

How does changing the concentration of CO_2 in the atmosphere affect the amount of energy in the atmosphere?

How does more heat in the atmosphere lead to changes in flow that lead to changing climate?

How will climate change affect the productivity of forests in Ontario?

How do forests contribute to reducing the energy imbalance in the atmosphere by removing atmospheric carbon?

What are the patterns of forest fires?

How might the change in the distribution of forest fires caused by climate change affect the pattern of forest fires?

Which forestry practices increase/decrease fire risks?

How can fire risk be reduced?

Climate Change Connections

- Changes to the atmosphere caused by greenhouse gases affect the balance of energy input and energy output for the planet. This is called the global radiation balance. Changing this balance changes the transfer of energy through wind patterns and ocean current patterns. Climate change is a consequence of these energy changes.
- Heat transfer is studied in terms of changes in the hydrosphere, where heat transfer takes place and where the consequences develop. Deforestation removes heat sinks and affects the water cycle.
- Forest composition is related to climate (boreal or mixed deciduous). If global climate changes, the distribution and survival of some forests will change. Such changes will also affect fire patterns. Consider the consequences of shifting wind patterns and ocean current patterns. This is like climate modeling.

Physics: Motion

Focus Questions

What are the traditional methods of cutting and removing timber from a forest?

How has harvesting technology and transportation technology changed?

How do these new technologies affect forestry practices?

How do different technologies contribute more/less to CO_2 production?

How does satellite technology help track the movement and spread of forest fires?

Climate Change Connections

- Compare the CO_2 emissions for different means of transporting wood out of a forest and for different harvesting technologies.
- Current transportation generally uses fossil fuels, which produce CO_2 and other chemical products.
- Recent changes in transportation and harvesting technology affect the speed of harvesting an area, and may affect the biodiversity of the area, which could then affect the area's ability for further growth.
- Satellite technology can be used to track physical conditions and fire patterns.

Resources

Textbooks

See "How Approved Textbooks Link to Learning about Climate Change" (pages 39-42) for an annotated list of topics.

Websites

Carbon budget

http://www.nrcan.gc.ca/cfs-scf/science/brochure_carbon_budget/carbon_e.html
This page explains the carbon budget model and makes specific references to forests and the cycling of carbon in forests at different stages.

http://www.climatechangesolutions.com/english/science/budget.htm
Simple explanation of model with sample values.

http://geochange.er.usgs.gov/pub/carbon/fs97137/
This is a very useful site that puts the idea of the carbon budget in the climate change context, with specific reference to the Mississippi Valley.

Forests and Forestry

http://www.glfc.forestry.ca/science/research/ecolecos_e.html
This site has very specific ecosystem information, with a special view towards forests.

http://ontariosforests.mnr.gov.on.ca/
The Ontario government's main page about forestry with many links.

http://www.algomaforest.com/
Algoma forestry information.

http://www.algonquinforestry.on.ca/
Algonquin foresty information.

http://www.ene.gov.on.ca/envision/news/2003/070401.htm
The Ontario government identifies criteria for forest management.

http://www.nofc.forestry.ca/climate/en/factsheets/factsheets_e.html
This Environment Canada site links to pages about climate change, carbon budget and a variety of forest types.

http://www.nofc.forestry.ca/climate/en/factsheets/factsheet9_e.html
This site from Environment Canada specifically considers forest fires in the boreal forest.

Vehicle Exhaust

http://www.osha.gov/SLTC/dieselexhaust/chemical.html

A good list of many components of diesel exhaust. Each chemical listed links to a chemical sampling information page.

http://www.nrdc.org/air/transportation/ebd/chap2.asp

Good site with health risks outlined and specific chemical products listed.

Weather

http://www.ontarioweather.com/summer/forestfire.asp

These links may not be active at certain times of the year.

http://www.spruce.ca/PPG/fire/index.htm

This site has photos of forest fires.

http://www.fire.uni-freiburg.de/current/Canada.htm

National fire monitoring and early warning.

Transportation

http://www.eia.doe.gov/oiaf/1605/gg96rpt/chap2.html

This site shows that CO_2 emissions from transportation produces about one-third of USA carbon emissions.

http://www.niwa.cri.nz/ncces/co2calc/

This New Zealand Residential CO_2 Calculator site allows students to calculate the amount of CO_2 produced by cars using gas or diesel, when distance (in km) is used.

Appendix 2.1 *Checklist of Preparation - Forestry Management and Climate Change*

As you work through the course of study, remember to use the checklist periodically to track the key ideas and skills you are acquiring as you prepare for the final assignment.

Checklist of Preparation

I can

- ☐ identify biotic and abiotic factors in an ecosystem
- ☐ research information about an ecosystem and forest management
- ☐ describe how forests change over time
- ☐ find and interpret data about ecosystems
- ☐ ask questions about the impact of chemical processes on the environment
- ☐ identify the products of forest fires
- ☐ identify the products of vehicle exhaust
- ☐ describe how weather can affect conditions for forest fires
- ☐ identify how climate change may affect forest fires in the future
- ☐ determine how different transportation choices produce more or less CO_2

Appendix 2.2 *Student Task and Expectations - Forestry Management and Climate Change*

Purpose: To outline and recommend good forestry strategies for a local forest to help maintain the carbon budget, reduce global climate change and support the Kyoto Protocol.

Scenario: A local forest provides timber for a pulp mill and softwood lumber for construction. The old growth forest was harvested in the 1800s, mostly for white pine. Spruce and balsam have been cut for pulp, but the construction boom in Southern Ontario has increased the value of logs that can be transported to that market for building construction. Local residents are concerned that cutting too much timber will reduce the value of the forest and hurt local ecosystems, which are also valuable for tourism. Some people are also concerned that increased cutting will contribute to climate change. The Ministry of Natural Resources requires that forest managers be certified for ISO 14001 Standards.

Several people in the area (environmental activist, forester, forest manager, municipal official) have been asked to outline and recommend good forestry practices that will help maintain the carbon budget, slow global climate change and help meet the goal of the Kyoto Protocol to reduce greenhouse gas emissions.

Student Task: You will choose (or be assigned) one of the following roles: environmental activist, forester, forest manager, municipal official. Using this assumed perspective, you will complete a report that outlines good forestry practices, and describe how they affect the value of the forest and the environment in terms of a specific ecosystem and the global climate.

The report is to explain how each choice connects to slowing climate change, thus helping to meet the goal of the Kyoto Protocol to reduce greenhouse gas emissions. A copy of your rough work and a list of sources should be included to support the recommendations made. Your report should answer these questions:

a) What are good forestry practices?
b) How do these practices reduce the environmental impact on local ecosystems?
c) How does this management strategy affect global climate?

Expectations: Use this list of expectations, along with Appendix 2.1 *Checklist of Preparation* to help you complete your assignment.

- examine how abiotic factors affect the survival and geographical location of biotic communities
- assess the impact of technological change and natural change on an ecosystem
- identify and evaluate Canadian initiatives in protecting Canada's ecosystems [e.g., Kyoto, MNR and ISO 14001 for forestry management]
- describe and explain qualitatively how factors such as energy, concentration, and surface area can affect rates of chemical reactions [and affect the frequency of forest fires]
- represent simple chemical reactions using molecular models, word equations, and balanced chemical equations [to show how new compounds are formed]

- explain how environmental challenges can be addressed through an understanding of chemical substances [e.g., reducing the production of CO_2 using effective technologies]
- describe and explain heat transfer within the water cycle and how the hydrosphere and atmosphere act as heat sinks [how do changes in local heat production affect local weather through the water cycle]
- describe and explain heat transfer in the hydrosphere and atmosphere and its effects on air and water currents
- investigate factors which affect the development, severity, and movement of global and local weather systems [What are the incidents of forest fire? Are global systems causing changes? What are predicted rates?]
- analyse everyday phenomena and technologies in terms of the motions involved [e.g., consider alternate transport systems]
- select and integrate information from various sources, including electronic and print resources, community resources, and personally collected data, to answer the questions chosen
- analyse data and information and evaluate evidence and sources of information, identifying flaws such as errors and bias
- analyse how technology is used for tracking the motion of objects and outline the kinds of scientific knowledge gained through the use of such technologies

Appendix 2.3 *Evaluation Rubric for Report*

Description	Level 1	Level 2	Level 3	Level 4
K/U Understanding of concepts	Concepts are simple, with gaps.	Concepts are mostly simple and complete	Ideas are developed with some depth	Concepts are complete and developed with insight
K/U Facts and terms used accurately and connect to concepts presented	Facts and terms are presented with limited accuracy and loosely connect to the concepts presented	Facts and terms used accurately and appropriately for the concepts presented	Facts and terms are used accurately and they connect and support concepts presented	Facts and terms effectively support the ideas presented so that the concepts are clear and easily understood
K/U Transfer of concepts to new contexts	Transfers a few simple concepts to new contexts	Transfers simple concepts to new contexts with some effectiveness	Transfers both simple and complex concepts to new contexts effectively	Transfers complex concepts to new contexts effectively
I Analysis and interpretation of data	Limited analysis and interpretation of data	Moderate analysis and interpretation of data	Considerable analysis and interpretation of data	Thorough analysis and interpretation of data
C Accurate use of scientific terminology, symbols, conventions and SI units	Limited accuracy of scientific terminology, symbols, conventions and SI units	Moderate accuracy of scientific terminology, symbols, conventions, and SI units	Considerable accuracy of scientific terminology, symbols, conventions, and SI units	A high degree of accuracy of scientific terminology, symbols, conventions, and SI units
C Use of report form	Limited command of the report form	Moderate command of the report form	Considerable command of the report form	Extensive command of the report form
C Use of information technology for scientific purposes	Researches appropriately, using the given resources	Researches appropriately using the given resources and useful additional sites	Researches appropriately using the given resources and additional sites that are effective	Researches appropriately using given sites and a variety of additional sites that are highly effective
MC Analysis of social and economic issues	Analyses forest practice in terms of simple social and economic issues	Analyses forest practice in terms of some social and economic issues	Analyses forest practice in terms of various social and economic issues	Analyses forest practice in terms of complex social and economic issues
MC Assessment of impacts of science and technology on the environment	Identifies and assesses how specific forest practice affects the area of interest	Explains and assesses how specific forest practice affects the area of interest	Explains and assesses how key forest practices affect the area of interest	Explains and assesses the impact of varied forest practices on the area of interest
MC Proposing courses of practical action in relation to identified problems	Extends analyses of problems into courses of practical action with limited effectiveness	Extends analyses of problems into courses of practical action with moderate effectiveness	Extends analyses of problems into courses of practical action with considerable effectiveness	Extends analyses of problems into courses of practical action with a high degree of effectiveness

HOW APPROVED TEXTBOOKS LINK TO LEARNING ABOUT CLIMATE CHANGE

Strand/Overall Expectations	Expectations Addressed	SciencePower 10	Science 10: Concepts and Connections
Biology: The Sustainability of Ecosystems • BYV.01D demonstrate an understanding of the dynamic nature of ecosystems, including the relationship between ecological balance and the sustainability of life • BYV.02D investigate factors that affect ecological systems and the consequences of changes in these factors • BYV.03D analyse issues related to environmental sustainability and the impact of technology on ecosystems	• BY1.01D Describe the processes of photosynthesis and cellular respiration as they relate to the cycling of energy, carbon, and oxygen through abiotic and biotic components of an ecosystem • BY1.06D explain why different ecosystems respond differently to short-term stresses and long-term changes • BY1.08D explain how soil composition and fertility can be altered in an ecosystem and identify the possible consequences of such changes • BY2.01D through investigations and applications of basic concepts, formulate scientific questions about observed ecological relationships, ideas, problems and issues • BY3.01D assess the impact of technological change on an ecosystem • BY3.05D identify and evaluate Canadian initiatives in protecting Canada's ecosystems	• pp 4-17 (energy in the food chain), 33-34 (human consumption) • pp 43-51 (carbon cycling, the cycling of oxygen is not covered) • pp 48-49 (carbon cycle, climate activity) • pp 26-34 (climate, food, DDT) • pp 74-80 (soil) • pp 81-91 (succession, ecosystems) • pp 454-461 (seasons, latitude, zones) • p 53 (human impact on the nitrogen cycle and soil) • pp 61-62 (acidity and soil lab) • p 63 (biodiversity) • pp 74-78 (soil) • pp 26-34 (human activity and climate) • pp 56-65 (human impact – soil, air, water) • pp 88-91 (change – activity and text) • pp 96-97 (Environmental Impact Assessment) • pp 33-34 (consuming the planet) • pp 112-122 (ecological footprint, technology) • pp 92-95 (land use) • pp 102-122 (managing resources, sustainability)	• pp 14-15 (ecology) • pp 22-25 (energy flow) • pp 26-29 (carbon cycle, photosynthesis and cellular respiration) • pp 6-13 (human impact, frogs, species at risk) • pp 34-37 (pesticides) • pp 42-44 (biomes) • pp 46-49 (soil) • pp 32-33 (fertilizer and ecosystems) • pp 52-55 (effects of acid precipitation) • pp 56-57 (greening of Sudbury) • pp 50-51 (logging forests)

How Approved Textbooks Link to Learning about Climate Change (continued)

Strand/Overall Expectations	Expectations Addressed	SciencePower 10	Science 10: Concepts and Connections
Chemistry: Chemical Processes ▸ CHV.01D demonstrate an understanding of chemical reactions, the symbolic systems used to describe them and the factors affecting their rates ▸ CHV.02D design and conduct investigations of chemical reactions, using standard scientific procedures, and communicate the results ▸ CHV.03D determine why knowledge of an chemical reactions is important in developing consumer products and industrial processes and in addressing environmental concerns	▸ CH1.03D describe, using their observations, the reactants and products of a variety of chemical reactions, including synthesis, decomposition, and displacement reactions ▸ CH1.04D describe qualitatively, using their observations, how factors such as heat, concentration, light, and surface area can affect rates of chemical reactions ▸ CH1.08D name and write the formulae for common ionic and molecular compounds ▸ CH2.09P represent simple chemical reactions using molecular models, word equations, balanced chemical equations ▸ CH3.01D explain how environmental challenges can be addressed through an understanding of chemical substances ▸ CH3.03D identify everyday examples where the rates of chemical reactions are modified	▸ pp 190-199 (chemical reactions) ▸ pp 203-206 (carbon reactions) ▸ pp 242-251 (factors that affect chemical reactions) ▸ pp 155-166 (chemical names and formulas) ▸ pp 170-174 (writing chemical equations) ▸ pp 155-162 (naming compounds) ▸ pp 200-201 (analyzing an industrial process) ▸ pp 231-236 (neutralization reactions)	▸ pp 86-87 (describing reactions) ▸ pp 92-95 (factors that affect reaction rates) ▸ pp 78-80 (naming atoms, ions and compounds) ▸ pp 82-83 (polyatomic ions and compounds) ▸ pp 90-91 (balancing chemical equations) ▸ pp 72-75 (household chemicals) ▸ pp 100-102 (food preservation)

How Approved Textbooks Link to Learning about Climate Change (continued)

Strand/Overall Expectations	Expectations Addressed	SciencePower 10	Science 10: Concepts and Connections
Earth and Space Science: Weather Dynamics • ESV.01D demonstrate an understanding of the factors affecting the fundamental processes of weather systems • ESV.02D investigate and analyse trends in local and global weather conditions to forecast local and global weather patterns • ESV.03D evaluate how technology has contributed to our understanding of the physical factors that affect the weather	• ES1.01D identify and describe the principal characteristics of the hydrosphere and the four regions of the atmosphere • ES1.02D describe and explain heat transfer within the water cycle and how the hydrosphere and atmosphere act as heat sinks • ES1.03D describe and explain heat transfer within the water cycle and its effects on air and water currents • ES1.04D describe and explain the effects of heat transfer within the hydrosphere and atmosphere on the development, severity, and movement of weather systems • ES2.06D investigate factors which affect the development, severity, and movement of global and local weather systems • ES3.01D explain the role of weather dynamics in environmental phenomena and consider the consequences to humans of changes in weather	• pp 441-446 (atmosphere) • pp 427-434 (water and energy transfer) • pp 435-441 (energy transfer) • pp 469-478 (currents, El Niño) • pp 422-426 (energy budget outlined) • p 446 (gases in the atmosphere) • p 447 (weather after global warming activity) • pp 462-480 (wind currents, ocean currents) • pp 502-512 (severe weather) • pp 486-495 (clouds, rain) • pp 496-501 (pressure systems) • pp 532-538 (forecasting) • p 447 (weather after global warming) • pp 475-478 (El Niño)	• pp 222-227 (atmosphere) • pp 212-213 (water and weather) • pp 214-215 (humidity) • pp 216-217 (water evaporation) • pp 230-231 (global wind patterns) • pp 232-233 (ocean currents) • pp 238-239 (extreme weather events) • pp 210-211 (regional weather) • pp 220-221 (factors that affect climate) • pp 234-235 (global weather model) • pp 242-243 (global climate)

How Approved Textbooks Link to Learning about Climate Change

Strand/Overall Expectations	Expectations Addressed	SciencePower 10	Science 10: Concepts and Connections
Physics: Motion • PHV.01D demonstrate an understanding of different kinds of motion and of the quantitative relationships among displacement, velocity, and acceleration, and solve simple problems involving displacement, velocity, and acceleration • PHV.02D design and conduct investigations on the displacement, velocity, and acceleration of an object • PHV.03D analyse everyday phenomena and technologies in terms of the motions involved	• PH3.01D evaluate the costs and benefits, including the environmental and safety factors, of technologies which have enabled us to travel at ever-greater speeds, and the impact of the increased capacity for speed on risk behaviour and subsequent injuries • PH3.03D analyse how technology is used for tracking the motion of objects and outline the kinds of scientific knowledge gained through the use of such technologies	• pp 284-294 (motion, transportation technologies) • pp 330-340 (faster technology) • p 402 (speeding, safety, and modern life) • pp 330-340 (modes of transport) • pp 374-375 (modes of braking) • pp 412, 413 (highway technology)	• pp 138-139 (traffic on highways) • pp 144-145 (choosing a vehicle) • pp 158-159 (smart highways)

TEACHER RESOURCES

SciencePower 10 Teacher's Resource Binder, Ontario Edition, Blackline Masters

Biology:
BLM 2-4 It's a Gas
BLM 2-5 Charting Carbon Changes
BLM 2-7 The Greenhouse Effect
BLM 2-8 Follow That Carbon Molecule
BLM 2-16 Dramatic Cycles (if carbon cycle used)
BLM 3-9 Land Use in Southern Ontario
BLM 3-10 Urban Use of Rural Lands
BLM 3-11 The Order of Succession
BLM 3-14 Sustainability at Work
BLM 3-17 Succession and Energy Flow
BLM 3-18 Soil Loss from Clearcutting
BLM 3-19 Remediation and Me
BLM 4-3 Environments in Distress
BLM 4-13 Calculating Ecological Footprints
BLM 4-14 Fossil Fuel Survey

Chemistry:
BLM 6-14 Naming Hydrocarbons
BLM 6-15 Building Hydrocarbon Models
BLM 6-16 Structural Figures for Hydrocarbons
BLM 6-17 Hydrocarbons in Industry
BLM 6-18 Chemistry Scavenger Hunt
BLM 6-19 Alternative Fuels
BLM 8-1 Factors That Affect Chemical Reactions
BLM 9-13 Controlling Harmful Emissions

Earth and Space Science:
BLM 13-1 Why is the Sky Blue?
BLM 13-2 Absorption or Reflection
BLM 13-3 Earth's Energy Budget Quiz
BLM 13-4 Change in Temperature of Water
BLM 13-9 Review of Energy and Water
BLM 13-10 Does Solar Energy Heat the Air?
BLM 13-12 Levels of the Atmosphere
BLM 13-13 Atmospheric Composition
BLM 14-3 Solar Energy and a Spherical Earth
BLM 14-5 Determining the Direction of Prevailing Winds
BLM 14-7 Worldwide Wind Currents Quiz
BLM 14-8 Ocean Gyres
BLM 14-9 The Gulf Stream and Climate
BLM 14-11 El Niño
BLM 14-12 El Niño
BLM 15-20 Severe Weather Quiz

Physics:
BLM 9-8 Transportation in Canada
BLM 9-11 The Bug Race

Nelson Science 10 Concepts and Connections: Student Record of Learning

Unit 1: Ecosystems and Human Activity

1.1 Disappearing Frogs
1.2 Going, Going, Gone!
1.3 Ecology
1.5 Investigation: A Schoolyard Ecosystem
1.7 Energy in Ecosystems
1.8 The Carbon Cycle
1.10 Explore an Issue: Should We Interfere with Natural Cycles?
1.11 Case Study: Pesticides
1.15 Soil
1.17 Logging Forests
1.20 Case Study: The Greening of Sudbury

Unit 2: Chemical Reactions and Their Practical Applications

2.1 Case Study: Household Chemicals
2.4 Polyatomic Ions and Compounds
2.6 Describing Chemical Reactions

Unit 3: Motion and Its Applications

3.1 Explore an Issue: Progress and Speed on Canadian Highways
3.4 Explore an Issue: How Could You Choose the Best Vehicle?
3.10 Case Study: Smart Highways

Unit 4: Weather Systems

4.1 Forecasting the Weather
4.5 Regional Weather
4.6 Water and the Weather
4.7 Humidity – Water in the Air
4.8 Investigation: What Affects the Evaporation of Water?
4.16 Global Weather Model
4.18 Case Study: Extreme Weather Events
4.20 Explore an Issue: Human Impact on Global Climate

Nelson Science 10 Teacher's Resource, Blackline Masters

Biology: Sustaining Ecosystems

Blackline Master 2.5 The Carbon Cycle
Blackline Master 3.2 How Does Temperature Affect Seed Germination?
Blackline Master 3.7 What's the Alternative?
Blackline Master 3.10 The Forests of the Temagami Region
Blackline Master 4.5a Areas of Concern in the Great Lakes – St. Lawrence Basin
Blackline Master 4.5b Great Lakes 2000 Cleanup Fund Habitat Rehabilitation Project

Chemistry: Chemical Processes

Blackline Master 5.12 Hydrocarbons Word Search
Blackline Master 7.2 Concentration and Rate
Blackline Master 7.8 Catalytic Converters – Reduce Automobile Pollution, But …

Earth and Space Science: Weather Dynamics

Blackline Master 13.8 The Saga of a Water Molecule
Blackline Master 14.5 Forms of Precipitation
Blackline Master 15.6c Hurricanes in Canada
Blackline Master 15.12 El Niño Visits Canada
Blackline Master 16.3 Fighting Forest Fires

Physics: Motion

Blackline Master 10.2 Speed Comparisons
Blackline Master 10.10 Acceleration of Different Vehicles: Sample Report

BACKGROUND RESOURCES

Websites

Climate Change. Government of Canada Environment Canada www.ec.gc.ca/climate/overview_what-e.html This site gives a summary and overview of climate change and links to other Canadian climate change sites.

Climate Change. Government of Canada. www.climatechange.gc.ca If you navigate this site's links, you will find information on provincial and territorial regional impacts, health impacts, the greenhouse effect, and a comprehensive overview of all climate change topics. It is ready to read for high school students. Included are global links and a resource list.

Regional Climate Change Poster Series – Climate Change in Canada. Natural Resources Canada. **http://adaptation.nrcan.gc.ca/posters/teachers/lesson_e.asp**

This site provides access to provincial and territorial posters about climate change including a teacher's guide and website. The topics in this poster series focus on weather/climate and ecosystems of Canada. It lists specific outcomes, links to the impacts of climate change on health, community, land, water, coastal regions, and different areas in Canada.

Weather Office. Government of Canada. **http://weatheroffice.ec.gc.ca/Canada_e.html**

This site offers interactive weather imaging and climate data. It includes seasonal change and forecasts, radarsat images, and the use of technology in weather and climate.

Confronting Climate Change in the Great Lakes Region (2003) Union of Concerned Scientists (UCS) and the Ecological Society of America. **www.ucsusa.org/greatlakes/pdf/solutions_ontario.pdf**

This is a major study written by university and government scientists in the Great Lakes region. Short summaries of the impact of climate change in Ontario and possible solutions have been co-authored by the David Suzuki Foundation. The solutions section has a helpful discussion of Canada's Kyoto Commitment. www.ucsusa.org/greatlakes/pdf/solutions_ontario.pdf

Global Warming Project. North Western University. **www.letus.nwu.edu/projects/gw/navigation.html.**

This project provides an approach to global warming through three parts: How Does Temperature Change?, What Makes Earth Warm?, and Addressing Climate Change. It has a teacher preparation section and introduction to global warming. The project can be done as a whole or separately to complement your unit.

Background Material. Global Climate Change. **www.ucar.edu/learn/1_4_1.htm.**

This site provides a background on climate change and its relation to carbon dioxide. It contains topics such as Climate Past, Present Climates and Human Activity, and Future Climates – the Great Uncertainty. Seven activities links follow that are useful in exploring these topics more thoroughly. They all focus on carbon dioxide.

Book

Grant, Tim and Gail Littlejohn, eds. *Teaching About Climate Change*. Gabriola Island, B.C.: New Society Publishers, 2001. These essays, both new and updated from *Green Teacher*, focus on the needs of teachers seeking solid background information, a balanced pedagogical strategy and a series of activities to give the subject of climate change a vivid reality. The collection is divided into five sections: Foundations, Energy Alternatives, Transportation Alternatives, The School Building and Home and Community. Includes a broad range of learning activities for all grades. Of special interest for Grade 10 Science students who select the Urban Sprawl and Transportation culminating task are articles on "Investigating Public Transit" and "Counting the Real Cost of Cars" (includes student worksheet). ISBN 086571-437-1

ONTARIO ECOSCHOOLS PROGRAM

Project Administrators
Richard Christie, Toronto District School Board
Lewis Molot, Faculty of Environmental Studies, York University

Project Manager
Eleanor Dudar, Toronto District School Board

Assistant Project Manager
Catherine Mahler

Steering Committee
Ron Ballentine, Halton DSB, Science Coordinators' and Consultants' Association of Ontario; Richard Christie, Toronto DSB; Judy Gould, Durham DSB; David Green, Toronto and Region Conservation Authority; Arlene Higgins-Wright, York Region DSB; Lewis Molot, York University; Pam Schwartzberg, Learning for A Sustainable Future

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ORDERING *INFORMATION*

Free copies of all Ontario EcoSchools guides may be downloaded in PDF format from York University's Faculty of Environmental Studies website at www.yorku.ca/fes/envedu/ecoschools.asp

The three multimedia presentations are available only on the *EcoSchools Resources for Ontario Schools* CD (both PC and Mac-compatible). **This CD also includes the Ontario EcoSchools guides and curriculum resources** and is available for the cost of shipping and handling. For ordering information, please contact:

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