THE Climate Change ACTION PACK

The Climate Change Action Pack

An interactive teaching supplement designed to:

- Increase the understanding among young Nova Scotians and educators of the science and issues of climate change
- Equip Nova Scotia's youth with the necessary knowledge to make informed decisions regarding lifestyle choices at home and in their future workplaces.

TABLE OF CONTENTS

Energy Section

Habitat Section

Appendix

THE CLIMATE CHANGE ACTION PACK WAS PRODUCED WITH THE SUPPORT OF

SCIENTISTS and INNOVATORS in the SCHOOLS

STANet
SCIENCE & TECHNOLOGY AWARENESS NETWORK

COOPERATION
Economic Diversification Agreement
Entente Diversification Économique

Canada

NOVA SCOTIA

Shell Environmental Fund

SABLE
OFFSHORE ENERGY

XEROX

XEROX

INTRODUCTION:

Climate change is perhaps the most important environmental issue facing the world today, with significant impacts on the environment, the individuals, the economy, and society.

The long term nature of the climate change issue makes youth an important audience. They will be the leaders of tomorrow and will face the challenge of climate change throughout their lives. The education system offers perhaps the greatest opportunity to reach youth in and organized and practical manner.

To this end, Scientists and Innovators in the Schools has been working on the climate Change Action Pack project since October 1998. An update was accomplished in 2005, and this 2010 edition will ensure that included material is current and curriculum-linked.

During the different states of the project, Scientists and innovators in the Schools

- assessed the needs of Nova Scotia teachers
- researched relevant existing Climate Change materials
- designed an elementary pilot project
- presented the material to teachers at professional development days and to University Education Professors
- tested the lessons within classrooms and summer camps, and
- designed the final version with suggestions compiled through feedback from the pilot
- reviewed and updated information and examples throughout the lessons to ensure that material is interesting and relevant to teachers and students

MANAGEMENT:

Overall direction for the Climate Change Action Pack was provided by a Steering Committee whose members bring to the project wide range of experience and expertise. Implementation and coordination of the project was the responsibility of Scientists and Innovators in the Schools.

Steering Committee

- Wayne Barchard, Senior Policy Advisor, Environment Canada, Committee Chair
- Norval Collins, NS Environmental Industries Association
- Joanne Desroches, Science Teacher, Halifax West High School
- George Foote, Program Administration Officer, NS Department of Natural Resources
- Judy McMullen, Executive Director, Atlantic Coastal Action Program Cape Breton
- Ian Millar, Science Marketing and Client Liaison, Natural Resources Canada
- Peter Oickle, Curriculum Consultant, South West Regional School Board
- Margaret Rockwell, Grade 4 Teacher, Bel Ayr School
- Anne Thompson, Regional Manager AtlanticCanada Industry Sector, Environmental Affairs, Industry Canada
- Heidi Tracey, Program Coordinator, Science and Technology Awareness Network
- Roger Hill, Executive Director, Discovery Centre

Karen Rockwell, former Program Coordinator of Scientists and Innovators in the Schools, coordinated the writing stage of the Climate Change Action Pack project. She is a Graduate of Carleton University's Bachelor of Journalism program. She has experience in the implementation of educational programming, including the coordination of bilingual educational programming at the Terry Fox Canadian Youth Centre in Ottawa and the design of an educational science outreach program for Guiding and Scouting groups in Nova Scotia.

Andrew Casey was the unit developer and co-author or of the Climate Change Action Pack as well as coordinator for the editing and distribution stages of the project. He is also a former Program Coordinator of Scientists and Innovators in the Schools (SITS). He is a graduate of St Francis Xavier University's Bachelor of Education Programme in Elementary Education and also has a Bachelor of Science Degree from McMaster University.

Jennifer Trott co-authored the Climate Change Action Pack. She is a graduate of St. Francis Xavier University's Bachelor of Education Programme in Secondary Education specializing in French and Social Studies Education. She also has a Bachelor of Arts Degree from Saint Mary's University.

Lori Crawford oversaw the editing and updating of the current edition of the Climate Change Action Pack and is current Program Coordinator of Scientists and Innovators in the Schools. She has a degree in Environmental Science from Acadia University, and experience in program and resource development.

Atlantic Science Links Association (ASLA)

Atlantic Science Links Association is a non-governmental charitable organization that coordinates predominantly volunteer-driven educational projects which support the Atlantic Science Curriculum.

ASLA's mission is to bridge the gap between the scientific community, schools and the public by:

- facilitating visits and activities by volunteer scientists, engineers and technologists to schools and public venues
- providing supporting advice, information and materials to teachers and to volunteering visitors that will enable them to effectively promote science and technology awareness and interest
- providing an appropriate referral service for teachers and the public to interested scientists, engineers and technologists.

Scientists and Innovators in the Schools (SITS)

Scientists and Innovators in the Schools is an outreach program of the Atlantic Science Links Association. With a mandate to promote science and technology awareness amongst Nova Scotia students, SITS is dedicated to nurturing relationships between the education and science communities in the province and helping students of all ages become more excited about science, technology, engineering, and mathematics.

SITS volunteers are scientists from industry, government, academia, and community organizations who understand the importance of providing Nova Scotia's young people with experiences and opportunities that encourage an interest and excitement about science.

In operation since 1989, SITS is a highly effective programme, reaching thousands of students each year. Through its various projects, which include school visits, career fairs, science fairs, workplace visits, field trips, and our Ask-A-Scientist website, SITS provides a vital link between the education and scientific communities, and offers teachers and other educators in Nova Scotia a focal point for expert scientific information, guidance and advice.

STRUCTURE:

Elementary teachers have told us again and again that they require hands-on, easy to follow lesson plans and activities that are curriculum based. The Climate Change Action Pack focuses on the units of weather, habitat and adaptation, and electricity that are presented in the Atlantic Canada Science Curriculum. The kit also addresses global studies, history, and components of social studies as well as the math and language arts curriculum. The Pack is flexible enough to use in any Grade 4 – 6 classroom. Extension activities are included as well as information sheets on other existing programs and projects.

Nova Scotia Connection

Another important concept that has been followed throughout this project was that the lessons should have strong connections to Nova Scotia. Lessons that are directly linked to this province would be ore applicable to our lives, easier for the students to relate to, and therefore easier for them to internalize the concepts by building on previous knowledge and interests.

Lesson Development

Lessons within each section are structured to build on each other. For example, the Earth Sciences section begins with the basics of weather and climate, and then examines why there are different climates around the world. Concepts are added until the focus of the lessons is the "Greenhouse Effect" and possible ways of reducing greenhouse gas emissions and their impacts. At the end of many lessons there are "Additional Activities" listed to help extend the lessons into other disciplines.

Backgrounders

Introducing many lessons are pages entitled "Stop for a Background Check!" These introduce the teacher to concepts that will be addressed in the lesson and provide information about other organizations in Nova Scotia that could provide further connections between Climate Change and the classroom.

Curriculum

Preceding each lesson there is a list of objectives for that specific lesson. This list describes basic concepts that are addressed in the activity. Following this introduction (pp. v – vi) are graphs of how to connect "Specific Learning Outcomes" (SLOs) from the Atlantic Canada Science Curriculum and the Common Framework of Science Learning Outcome to individual lesson in this binder. The lessons address almost all of the SLOs that teachers are responsible for from Gr. 4 to 6. Please note that if there are many SLOs connected to a lesson, focus may be emphasized on any specific one.

Grade 4 Curriculum Links

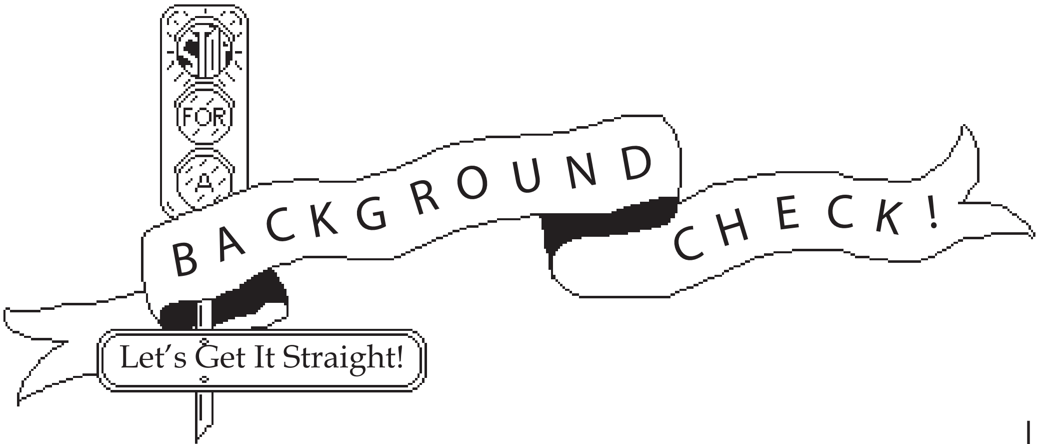
	Specific Learning Outcomes	Earth Science										Energy					Habitat								
		1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	1	2	3	4	5	6	7	8	9
Sciecne, Technology, Society, and the Environment (STSE)	104-1			✓	✓		✓	✓	✓		✓				✓	✓		✓					✓	✓	✓
	-4			✓	✓		✓	✓			✓							✓		✓	✓		✓		
	-6							✓	✓			✓	✓	✓			✓							✓	
	105-1							✓	✓	✓				✓	✓						✓		✓	✓	
	-4			✓				✓	✓		✓			✓											✓
	106-1				✓																				
	-4				✓			✓	✓	✓	✓			✓							✓		✓		
	107-1								✓	✓					✓						✓				
	-4								✓	✓					✓						✓				
	-7															✓									
	-13		✓																						
	108-1													✓											
	-3								✓	✓	✓			✓	✓		✓			✓	✓	✓			
	-6								✓	✓	✓				✓	✓	✓			✓	✓	✓	✓		
Skills	204-3	✓						✓															✓		
	-6									✓															
	-7									✓					✓										
	-8														✓										
	205-1			✓	✓		✓	✓						✓									✓		
	-2																						✓		
	-3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓			✓		
	-4				✓									✓							✓				
	-5	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	-7	✓					✓	✓				✓	✓	✓	✓	✓		✓		✓	✓		✓	✓	
	-8	✓	✓								✓			✓	✓	✓									
	-10							✓															✓		
	206-1	✓								✓		✓	✓	✓		✓	✓	✓						✓	
	-2	✓			✓			✓	✓	✓	✓				✓			✓		✓	✓		✓	✓	
	-3	✓			✓			✓	✓		✓				✓	✓				✓	✓		✓		
	-5	✓			✓			✓	✓	✓	✓				✓							✓	✓		
	-6							✓	✓	✓	✓				✓										✓
	-7																								✓
	-9				✓			✓	✓	✓					✓		✓	✓			✓		✓		✓
	207-1		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓							
	-2		✓			✓	✓	✓		✓		✓		✓	✓	✓		✓							
	-6		✓				✓								✓										
Knowledge	300-1		✓													✓	✓	✓	✓	✓					✓
	-2																	✓						✓	
	-6																	✓							
	301-1																✓	✓							
	-2																✓			✓		✓	✓	✓	
	-5	✓																							
	-6								✓																
	-7	✓																							
	302-1																✓	✓	✓					✓	
	-2																✓		✓	✓		✓	✓		✓
	303-3				✓																				
	-9																	✓							

Grade 5 Curriculum Links

	Specific Learning Outcomes	Earth Science										Energy					Habitat								
		1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	1	2	3	4	5	6	7	8	9
Sciecne, Technology, Society, and the Environment (STSE)	104-2			✓				✓	✓		✓				✓			✓							
	-5				✓			✓			✓									✓					
	-7							✓	✓			✓		✓										✓	
	105-2							✓					✓			✓			✓						
	-5	✓						✓						✓											
	106-2						✓																		
	-4				✓			✓	✓	✓	✓			✓							✓		✓		
	107-2								✓	✓			✓			✓					✓				✓
	-5				✓				✓	✓			✓			✓					✓				✓
	-8															✓									
	-14		✓																						
	108-1													✓											
	-4								✓	✓	✓			✓	✓						✓				✓
	-7								✓	✓	✓				✓	✓	✓			✓	✓	✓	✓		
Skills	204-3	✓						✓												✓			✓		
	-4							✓					✓	✓											
	-5				✓			✓																	
	-7									✓					✓										
	205-1			✓	✓		✓	✓						✓									✓		
	-2							✓	✓														✓		
	-3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓			✓		
	-4				✓									✓							✓				
	-5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	-6			✓					✓						✓						✓		✓		
	-7	✓					✓	✓				✓	✓	✓	✓	✓		✓		✓	✓		✓	✓	
	-8	✓	✓								✓			✓	✓	✓									
	-9				✓		✓	✓																	
	-10							✓															✓		
	206-1	✓								✓		✓	✓	✓		✓	✓	✓						✓	
	-2	✓			✓			✓	✓	✓	✓				✓			✓		✓	✓		✓	✓	
	-3	✓			✓			✓	✓		✓				✓	✓				✓	✓		✓		
	-4										✓													✓	
	-5	✓			✓			✓	✓	✓	✓				✓						✓		✓		
	-6							✓	✓	✓	✓				✓										✓
	-8				✓					✓	✓				✓		✓	✓			✓		✓	✓	
	-9				✓			✓	✓	✓					✓		✓	✓			✓		✓		✓
	207-1		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓							
	-3		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓										
	-4		✓			✓	✓	✓			✓	✓	✓	✓	✓										
	-5		✓		✓	✓	✓	✓							✓										
Knowledge	300-11						✓																		
	-13	✓																							
	-14								✓																
	301-11								✓																
	-12								✓																
	-13								✓																
	-14	✓																							
	302-11	✓		✓	✓	✓																			
	303-21	✓		✓	✓			✓	✓																

Grade 6 Curriculum Links

	Specific Learning Outcomes	Earth Science										Energy					Habitat								
		1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	1	2	3	4	5	6	7	8	9
Sciecne, Technology, Society, and the Environment (STSE)	104-3							✓	✓					✓											
	-5				✓			✓			✓									✓					
	-8							✓				✓		✓										✓	
	105-3							✓								✓									✓
	-6							✓	✓	✓				✓											
	106-3				✓																				
	-4				✓			✓	✓	✓	✓			✓							✓		✓		
	107-3		✓	✓					✓	✓				✓							✓				
	-6			✓					✓	✓				✓							✓				
	-9		✓						✓	✓	✓					✓					✓				✓
	108-2													✓											
	-5								✓	✓	✓			✓	✓		✓			✓	✓	✓			
	-8								✓	✓	✓			✓	✓	✓	✓			✓	✓	✓	✓		
Skills	204-3	✓						✓															✓		
	-4							✓					✓	✓											
	-5				✓			✓																	
	-6									✓				✓											
	-7									✓					✓										
	-8														✓										
	205-2							✓	✓														✓		
	-3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓			✓		
	-5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	-7	✓					✓	✓				✓	✓	✓	✓	✓		✓		✓	✓		✓	✓	
	-8	✓	✓								✓			✓	✓	✓									
	-9				✓		✓	✓																	
	206-1	✓								✓		✓	✓	✓		✓	✓	✓						✓	
	-2	✓			✓			✓	✓	✓	✓				✓			✓		✓	✓		✓	✓	
	-3	✓			✓			✓	✓		✓				✓	✓				✓	✓		✓		
	-4										✓													✓	
	-5	✓			✓			✓	✓	✓	✓				✓						✓		✓		
	-6							✓	✓	✓	✓				✓										✓
	-9				✓			✓	✓	✓					✓		✓	✓			✓		✓		✓
	207-2		✓			✓	✓	✓		✓		✓		✓	✓	✓		✓							
	-4		✓			✓	✓	✓			✓	✓	✓	✓	✓										
Know-ledge	300-15																							✓	
	303-28												✓	✓											
	-29												✓	✓	✓										
	-30													✓	✓	✓									



As you learn more about climate change, you'll need to understand some key terms.

Climate Change

Climate includes all the elements of weather. When we speak of climate change we are referring to changes in the climate as a whole, not just one single element of the weather. Global climate change, therefore, refers to the changes in all the interconnected weather elements of the Earth. Scientists know that the world's climate has changed naturally over millions of years. Many scientists strongly believe that the actions of humans are also changing the world's climate.

Greenhouse Effect

This is the process of trapping heat in the atmosphere by gases known as greenhouse gases. These are namely water vapour, carbon dioxide, methane, and nitrous oxides. Many scientists believe the Earth has a natural greenhouse effect but also an enhanced greenhouse effect caused by human actions.

Global Warming

Global warming refers to natural or human-induced increases in the average global temperature of the atmosphere near the Earth's surface. Many scientists believe that humans are contributing to global warming through the creation of greenhouse gas sources and the reduction of carbon sinks such as forests.

Ozone Layer

Many people confuse a decrease in ozone with the term "greenhouse effect". In fact, these are two separate phenomena. It is true that in the lower atmosphere ozone is a pollutant. We often see this as smog in larger cities. In the stratosphere, however, ozone provides an essential shield against ultraviolet radiation. The highest concentrations of ozone are in the stratosphere - about 90%. The ozone layer absorbs or screens out about 99% of all ultraviolet radiation coming from the sun. Scientists have noticed a depletion of ozone over Antarctica. Although this has been referred to as a hole, it is better to say that a relative depletion in concentration has taken place. Many scientists believe that a reduction in ozone concentrations is the result of chloroflourocarbons, which have been used as propellants in hair sprays and deodorants, and in air-conditioning units and refrigeration.

Scientists are finding more links between the greenhouse effect and the ozone layer. But remember that the enhanced greenhouse effect refers to a build up of greenhouse gases in the lower atmosphere. This may lead to global warming. A decrease in ozone in the stratosphere, however, may lead to an increase in ultraviolet radiation arriving at the Earth's surface.

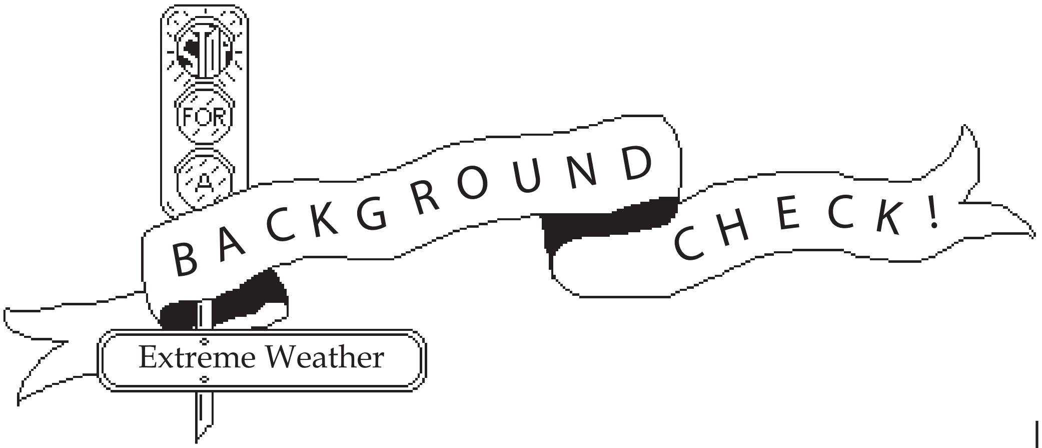
Key Words

Climate Change,
Greenhouse Effect,
Global Warming,
Ozone Layer

Sources

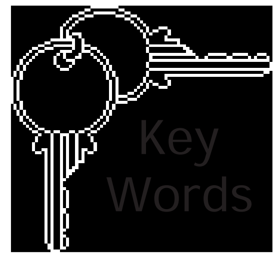
Climate Change: Picturing the Science G. Schmidt et al. 2009

Environmental Science: Systems and Solutions. M.L. McKinney et al. 2007



The following lesson deals with the possible increase in extreme weather events due to climate change. To truly link extreme weather with climate change, studies must be done over long periods of time, from decades to centuries, and across the entire world, not just one country or province. The following lesson however, is meant to get the students involved while increasing their awareness of the province and country around them.

Following is information concerning this issue, adapted from the UNFCCC (United Nations Framework Convention on Climate Change) Climate Change Information Kit. Please check the web-site listed in the Source section of this Background Check for further information about climate change.



Extreme Weather,
UNFCCC,
Regional

Climate Disasters and Extreme Events

Natural variability often leads to climate extremes and disasters. On time scales of days, months, and years, weather and climate variability can produce heat waves, frosts, floods, droughts, severe storms, and other extremes. It is possible that greenhouse gas–induced climate change will alter the frequency, magnitude, and character of extreme weather events.

Why Look At Different Regions?

Every region of the world experiences record–breaking climate extremes from time to time.During the heatwave of August 2003, in which 35,000 people died from heat related symptoms across Europe, temperatures in France remained near 40 degrees Celsius for two weeks. In 2007, 30 million people in India, Bangladesh and Nepal were affected as South Asia's worst monsoon flooding in recent memory destroyed croplands, livestock and property.That same year, the first documented cyclone in the Arabian Sea, Cyclone Gonu, made landfall with sustained winds near 148 km/h Records were set throughout Canada during the winter of 2008, as snowfall reached 550 centimeters in many locations, including Quebec City.

Are We Sure?

Do today's frequent reports of record–breaking events necessarily mean that climate extremes are becoming more common? According to the Intergovernmental Panel on Climate Change, "At continental, regional and ocean basin scales, numerous long-term changes in climate have been observed. These include changes in arctic temperatures and ice, widespread changes in precipitation amounts, ocean salinity, wind patterns, and aspects of extreme weather including droughts, heavy precipitation, heat waves, and the intensity of tropical cyclones."

The research of the IPCC has shown that:

- Stronger westerly winds have been observed in the mid-latitudes of both hemispheres.
- More intense and longer droughts have been observed in the Sahel, the Mediterranean, southern Africa and parts of southern Asia.
- The frequency of heavy precipitation events has increased over most land area, particularly in eastern parts of North and South America, northern Europe and central Asia.
- Cold days, cold nights and frost have become less frequent, while hot days, hot nights, and heat waves have become more frequent.

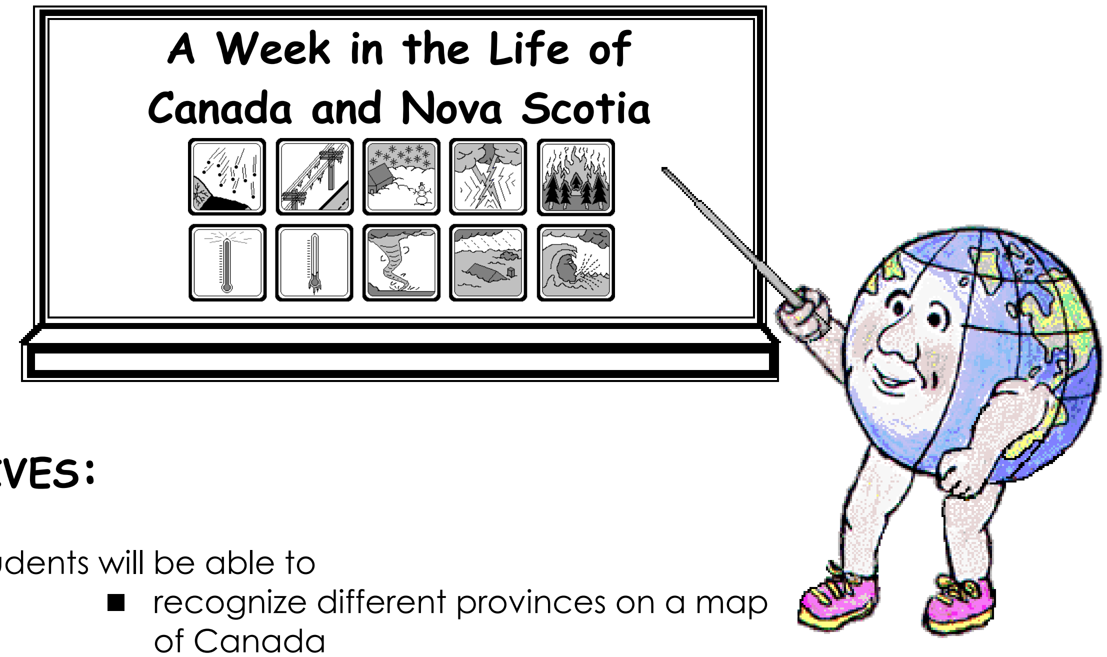
However, extreme events last for a relatively short time and are usually a local experience, making it difficult for scientists to predict how these events might respond to climate change.

Source

UNFCCC Climate Change Information Kit

http://unfccc.int/essential_background/background_publications_htmlpdf/climate_change_information_kit/items/305.php

Earth Sciences : Lesson #1



OBJECTIVES:

Students will be able to

- recognize different provinces on a map of Canada
- recognize different locations on a map of Nova Scotia
- collect up to date weather data from newspapers, news, and/or Internet
- present information in a display format
- describe the outcomes of different extreme weather events

MATERIALS:

Wall map of Canada and another of Nova Scotia, at least 2 copies of all the extreme weather icons, 4 blank icon templates, 4 copies of the 1st Place ribbon, event information slips, fact sheets, Internet access (optional), up to date national and/or local newspapers (optional), string, sticky putty

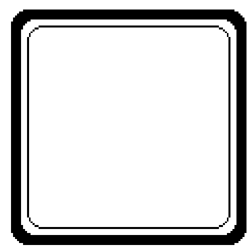
PROCEDURE:

INTRODUCTION:

Ask the class to suggest different possible severe weather conditions that do occasionally exist in Canada. Write each condition on the board. Go back and have the students suggest answers to the following questions about each condition. Write their answers in point form beside the appropriate event headings.

How is it related to weather?
Name some negative effects?
Are there any positive effects?
How can it change the environment?
Do we get such events in Nova Scotia?
How good is the warning system?
What should you do in the case of such an event?

Bring out the pre-made icons and display them to the class one-by-one. First, show any that are already listed on the board and have the class guess which event it depicts (hail, ice storms, snow storm, high temperature, low temperature, tornado, lightening storm, lightening instigated forest fire, flooding, hurricane). Attach the icon to the board where it is described. Show any icons that have not been listed and take guesses as to the severe weather conditions that the icons could be depicting. Answer the above questions concerning the new events.



If the class thought of a weather condition that was not depicted by one of the pre-existing icons, have a student make a new icon by using a copy of the blank template provided. Either assign the student that thought of the event in the first place or ask for a volunteer to help.

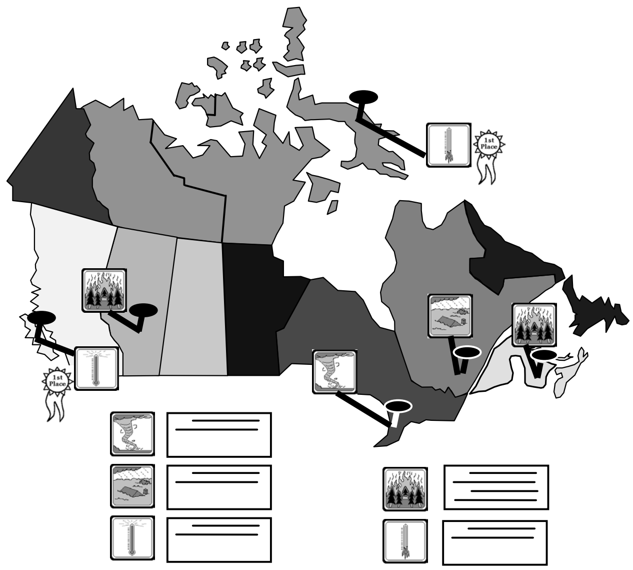
MAIN ACTIVITY:

Each day of the week every student in the class is asked to come to school with extreme weather related events that took place within the last 24 hours. One should be from inside Nova Scotia and the other from another part of Canada. Students can use the Internet, newspapers, radio, or television to collect such information. For students who were unable to find any information, there could be a resource table provided in the classroom that is equipped with both national and local papers and/or Internet hook-up with suggested sites to visit.

Have the students fill in the event information sheet with the date, location, and description of the event. Post the corresponding icon on the appropriate map (Canada or Nova Scotia) beside the location where the event took place. Tape or tack one end of a string to the icon and the other end to the actual location that the event took place in. Beneath the maps, keep a key of the different icons used, and the event information sheets that go with each icon.

Use the thermometer icons for both the Nation's and the Province's highs and lows in temperature for each day recorded. Attach the 1st place ribbons to the icons that represent the highest and lowest of all the recorded temperatures for Canada and again for all the recorded temperatures for Nova Scotia.

Assign students to find the average high and low temperatures for each day (posted in the newspaper or on the Internet) for Nova Scotia and Canada. Post this information below the map with the presently recorded highs and lows.



CONCLUSION:

Inform the class that one of the environmental issues facing the world today is called Climate Change. Scientists believe that the world's climates are changing slowly. The main change that scientist believe is that the global temperature is warming up. This not only causes record highs in temperatures but also an increase in extreme weather events.

Students can check to see if any of their high temperature readings are a record for that area on that day of the year. They can also check how far their highs and lows are away from the averages for those days. Also, the students should have an open discussion on whether they believe their data shows an increase in activity from years past (ex, 1st tornado reported in PEI since …).

Finish by reminding students that data can be deceiving. The increases in extreme weather conditions and temperature are over a long period of time (typically decades) and cannot be reliably observed in only one week's collection of data.

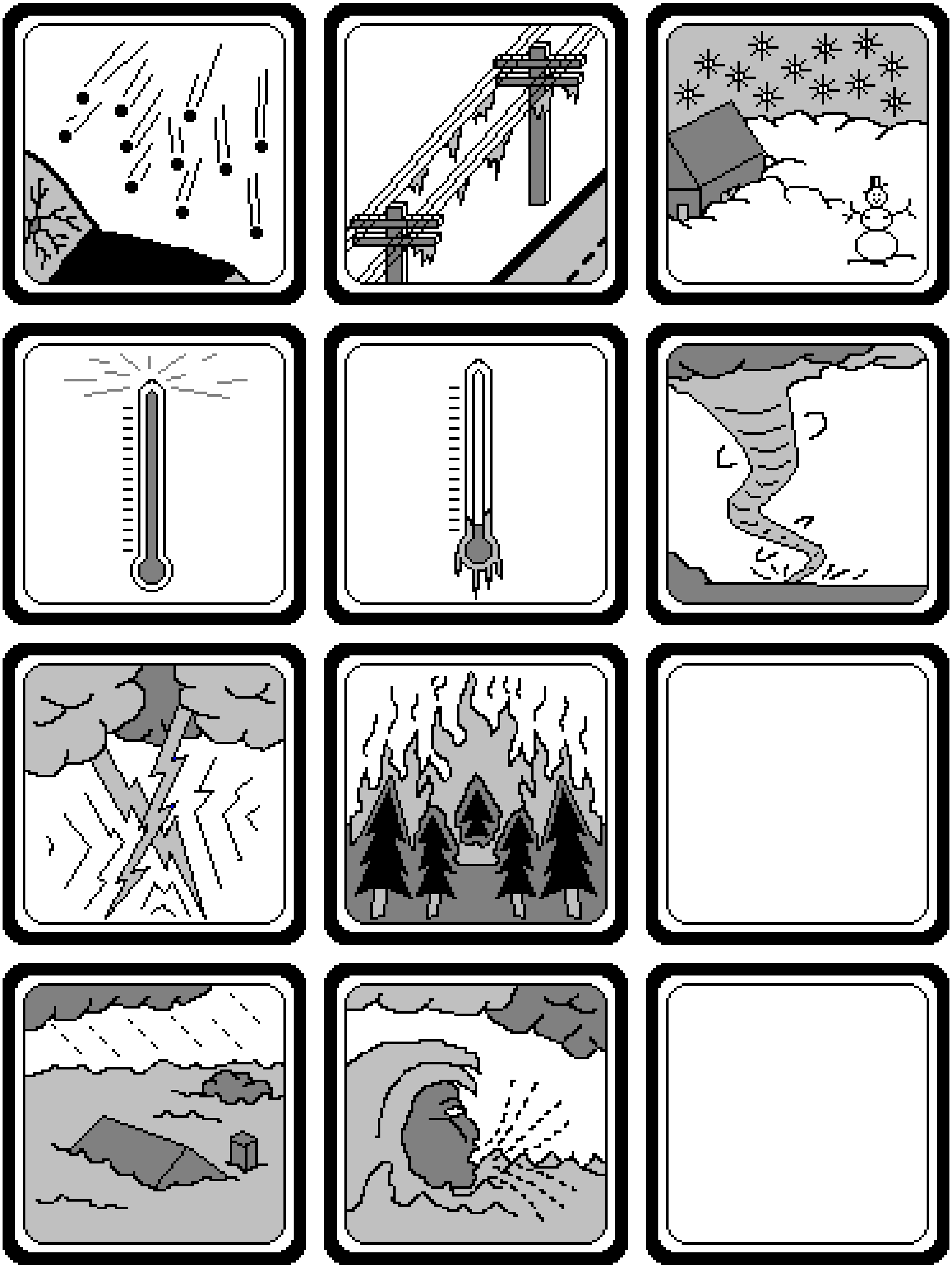
Additional Activities

Mathematics:

- How big a temperature range exists between the recorded highs?
- Is this bigger, smaller or the same as the range between the recorded lows?
- Predict and then calculate the difference between the overall lowest and highest recorded temperatures for the week. How does Nova Scotia's range compare to the rest of the country's range in temperature?

Language Arts:

- Choose one of the icons and write a story about an adventure involving that extreme weather condition. (example, a story about a fictitious flood, "The Day I Took the Boat to School")
- Write your own newspaper article based on an actual event displayed on the map. You can make up your own "late breaking" story by making up something and pretending that the other papers had missed it or did not follow through with their research to find out the rest of the story. (example, "There's No Place Like Home", an article about a kitten that was lost in an Alberta Tornado but found a week later when it returned back to its house unharmed.)



Background Check!

Climates

The term climate refers to the generalization of weather patterns in a given area over a long period of time. Essentially, it is the average of weather over a long period of time. Scientists can talk about the climate of a small region, like a farm. This is called a microclimate. Climate can also refer to weather patterns in a given metropolitan area. This is known as the local climate. A climate that refers to several provinces might be referred to as a macroclimate. When climatologists talk about climate, they need to gather information on temperature, humidity, precipitation, prevailing wind conditions, pressure, and storms.

In the following lesson, places from around the world were selected in order to show a range of different climates. Some nations are small enough to be looked at as a whole (Ireland) while others are so large that distinctively different climatic areas can be found (Canada). In such cases, students need only consider the section of the country mentioned (Nunavut).

One climatologist in particular, Wladimir Köppen, invented a way to classify the world's climates. Although his system is not perfect, it is fairly easy to understand. Köppen talked about six major climate types. Each type has two or more sub-climates. Here are Köppen's climate classifications.

Tropical Rainy Climates

Tropical Rainy Climates are characterized by year-round high temperatures and abundant rainfall. In fact, it is not usually less than 88.9 cm. These climates have lots of thunderstorms. If the tropical rainy climate has no drought period, its sub-climate is said to be a *Tropical Rainforest*. Tropical rainforests are found in Brazil, Central Africa, Central America, Central South America, and the East Indies.

If the region has a brief but definite drought season, it is called a *Tropical Savanna*. Brazil, Northern Australia, and South and Southeast Asia have tropical savanna regions.

A climate is referred to as *Tropical Monsoon* if it receives a significant amount of rainfall. Colombo, Sri Lanka, as well as Coastal India, Coastal South America, and Coastal South East Asia have monsoon regions.

Dry Climates

Dry climates receive meager precipitation but have excessive evaporation potential. These climates also usually show a wide annual temperature range. Some Dry Climates are hot. Others are freezing cold!

Key Words

Microclimate, Macroclimate, Local Climate, Wladimir Köppen, Tropical, Dry, Humid Mesothermal, Humid Microthermal, Polar, Highlands

The first sub climate of the dry climate is called *Steppe Climate*. This climate borders a true desert. Steppe climates support minimal plant growth. Temperature is usually severe for the latitude. Denver, Colorado is an example.

A second sub climate is the familiar *Desert* , which is present on almost all continents. Deserts have insignificant precipitation and large daily and annual temperature ranges. Yuma, Arizona is an example of a desert.

Humid Mesothermal

Seasonal changes are characteristic in humid mesothermal climates. These climates are influenced by westerly winds.

In the sub climate, *Mediterranean or Dry Summer Sub-tropical*, temperatures along the coast don't vary much. Summers are warm but short and precipitation is concentrated in the winter. Portugal and Italy fit this classification.

Humid Subtropical regions have mild winters and long, hot summers. Most of Florida has this climate.

Marine West Coast regions usually have mild, marine conditions and abnormally mild winters and cool summers. Victoria, British Columbia has such a climate.

Humid Microthermal Climates

These regions, located in continental interiors, have colder, longer winters and greater seasonal temperature ranges.

Humid Continental, long summers are seen in regions like Allentown, Pennsylvania.

Here at home in Nova Scotia we experience the *Humid Continental, short summers* sub climate.

Subarctic regions have larger temperature ranges and short cool summers. The common vegetation in these climates, called taiga, is a moist coniferous forest. Whitehorse, Yukon has a subarctic climate.

Polar Climates

Not surprisingly, polar climates are continuously cold and dry. The sun arrives at these regions at low angles. In the subclimate known as the *Tundra,* no true summer exists. It briefly remains above freezing in the summer, only long enough to support lichens and mosses. Frobisher Bay on Baffin Island is a tundra region.

The world's *Ice Caps* have small temperature ranges and very cold temperatures. Ice sheets can be as thick as 3.2 km! Eismitte, Greenland is located on top of an ice sheet. These regions receive very little precipitation – only about 11cm a year.

Highlands

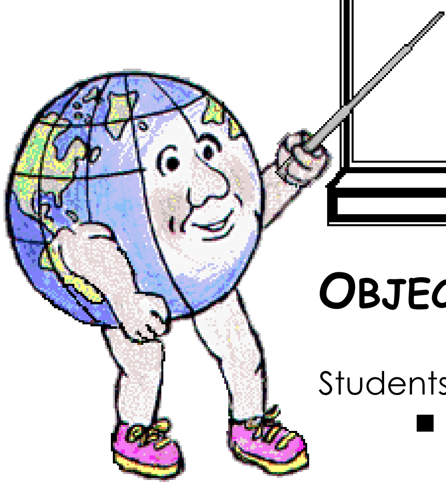
The highlands have highly varying temperature and moisture conditions. At higher latitudes, more pole-like conditions are experienced. The Rocky Mountains in Western Canada fit this classification.

Source

Physical Geography: The Global Environment. 3rd Ed. Oxford University Press, 2004

Earth Sciences : Lesson #2

Around the World



Objectives:

Students will be able to

- explore the climate, habitat, food, and geographic location of another culture
- work cooperatively in groups to complete brochures
- make decisions about what is important to put in their brochure
- practice communication skills by presenting their brocure to the class

Materials:

One brochure sheet per group, 25 rough draft sheets, colour pencils, information sheets on the places/cultures that the groups will be researching, other books on these places/cultures, 6 flags

Procedure:

Introduction:

Explain to the students that several cities around the world have asked for our help. The people in these geographical areas are presently planning their annual tourism campaign. The climates of these areas are interesting for visitors. These places want to show off and let potential tourists know about their geographical surroundings through brochures and posters. Visitors will need to know what to wear, what to bring, what kinds of activities they can expect to do, and what kind of habitats they will see.

This activity needs groups of five. Each group will be researching and developing a brocure on a specific area and culture. The flags of the six areas that are mentioned should be cut into five numbered pieces and randomly disturbed to the class. If more are needed for the groups, divide a piece into two pieces and number them a and b (ex. 5a and 5b). The students must find the other pieces that make up their flag. This method will decide who is in what group. A student will be assigned to gather all the necessary materials for their particular group.

Give each group a Fact Sheet about their city and its surroundings. You many want to create new fact sheets if some of the students are interested in, or are from, geographical areas that are not yet included in the lesson. If so, the appropriate flag can be found at the following website: http://www.crwflags.com/fotw/flags/cbk.html.

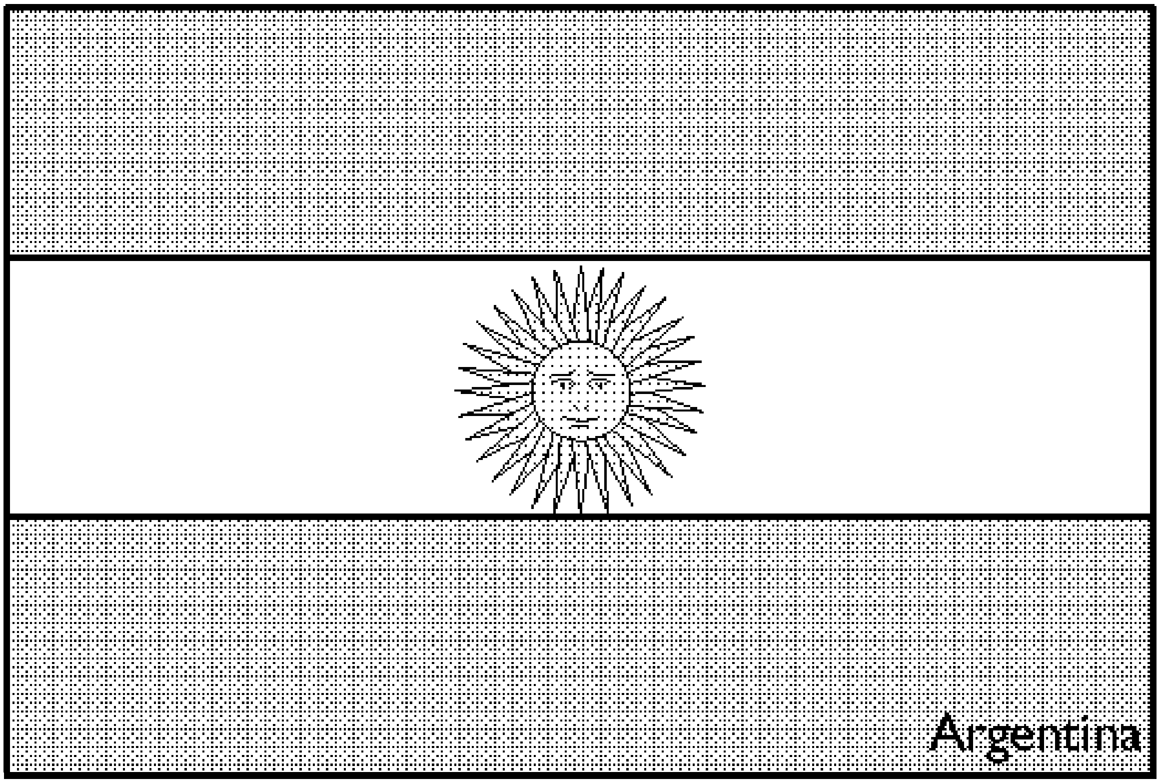
Main Activity:

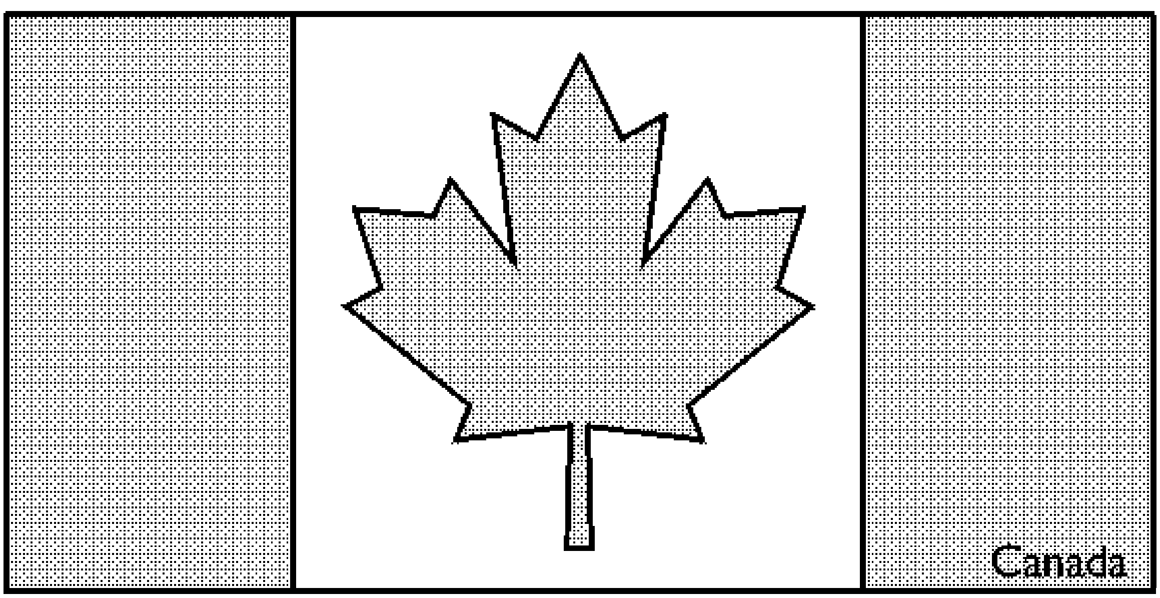
The different sections of the brochure are divided amongst the group members. The students will create their section of the brochure on scrap paper based on what they have read about their place. After the rough draft is complete, the teacher will edit it. The students will then proceed to make a good copy. Those who finish early and are waiting for the brochure to come to can help another group member with the research and give ideas if necessary.

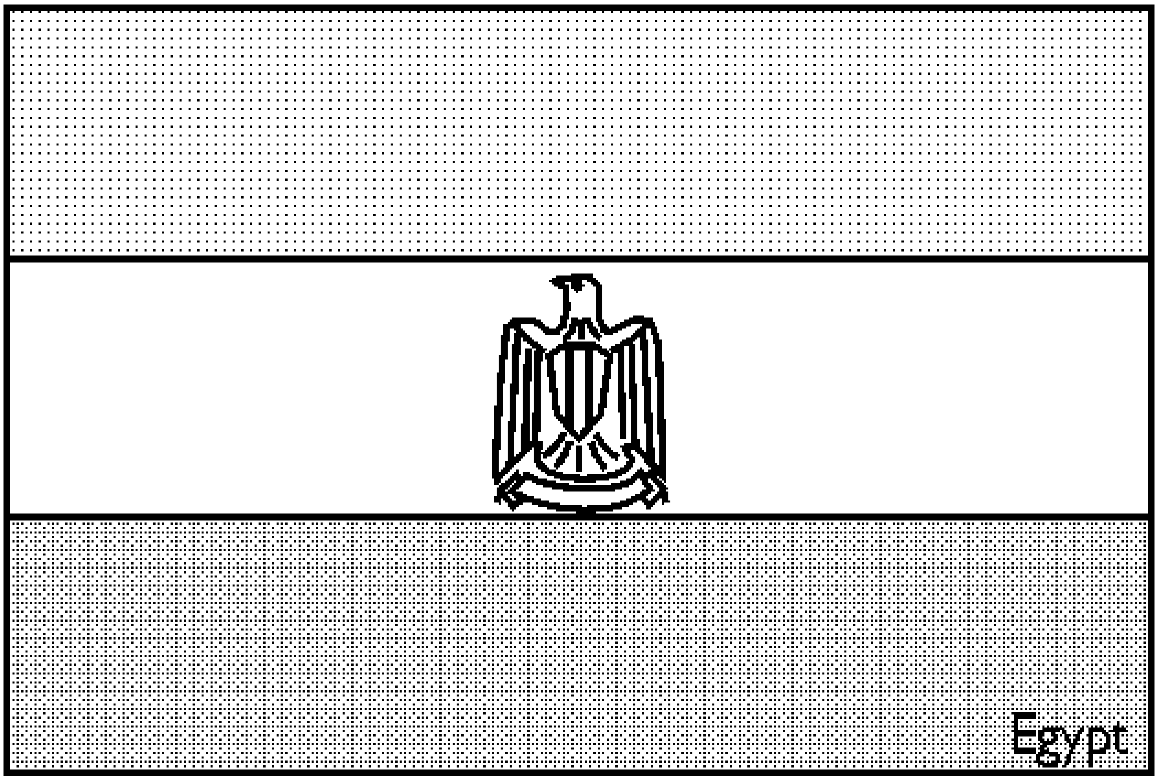
After the brochure is completed, two possible methods of presentation are possible. Each group could present to the class, explaining how they divided up the work, what their edited changes were, and the brochure information itself. Another possibility is to create expert groups. All the students who had a flag piece with the number one may create a group of their own. The same is done for 2 to 5. This way the groups are made up of presenters from each brochure. They then take turns presenting the entire brochure to each other.

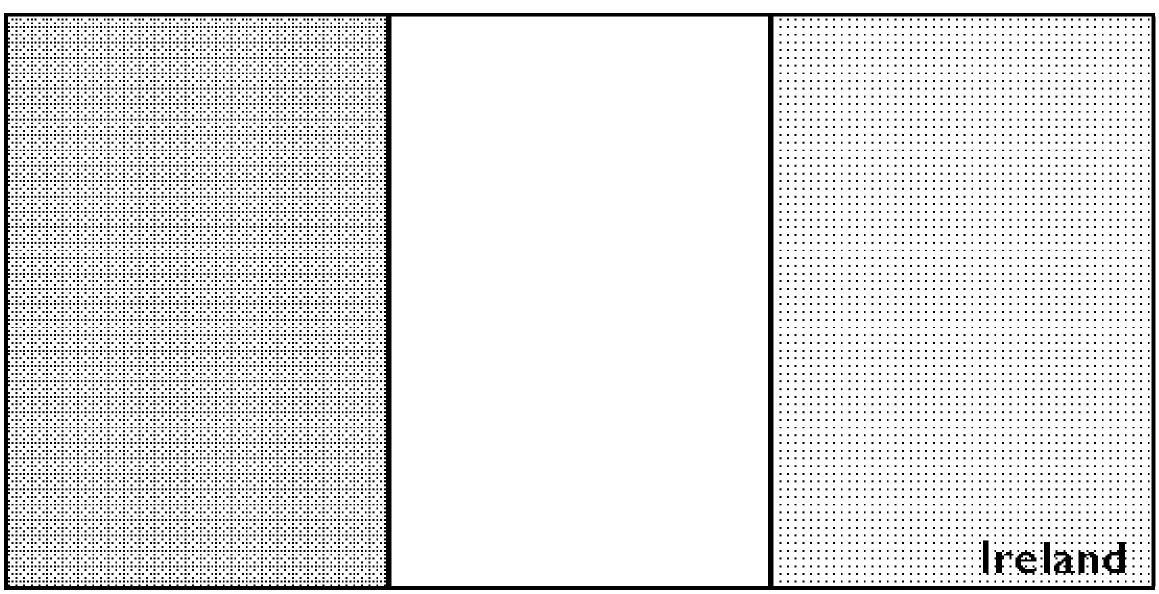
Conclusion:

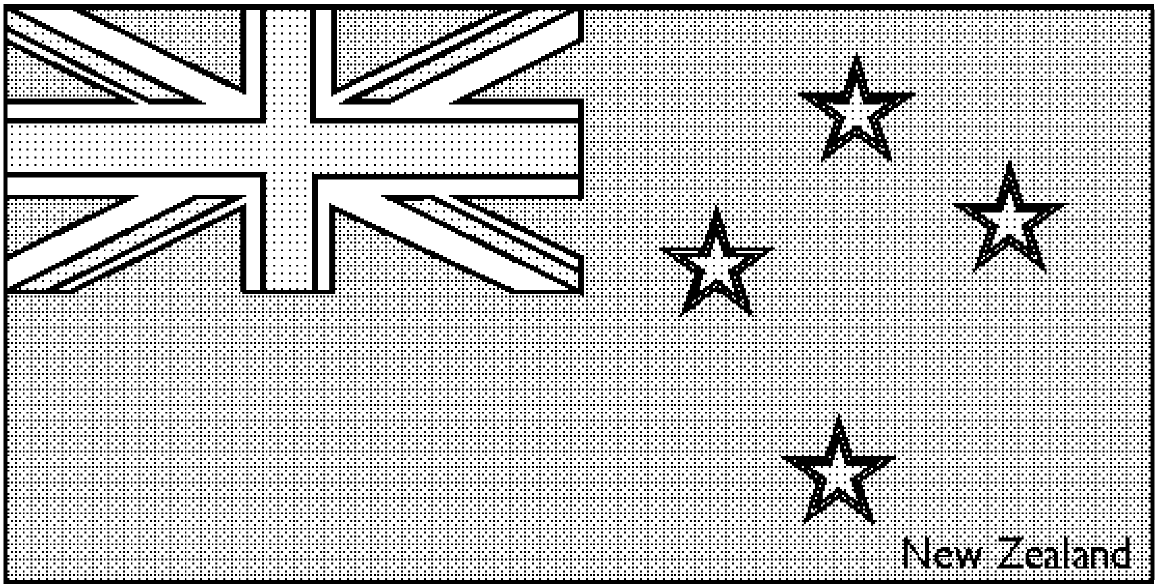
Each group is in charge of cleaning their workspace. The finished product could be posted in the corridor for the whole school and visitors to view.

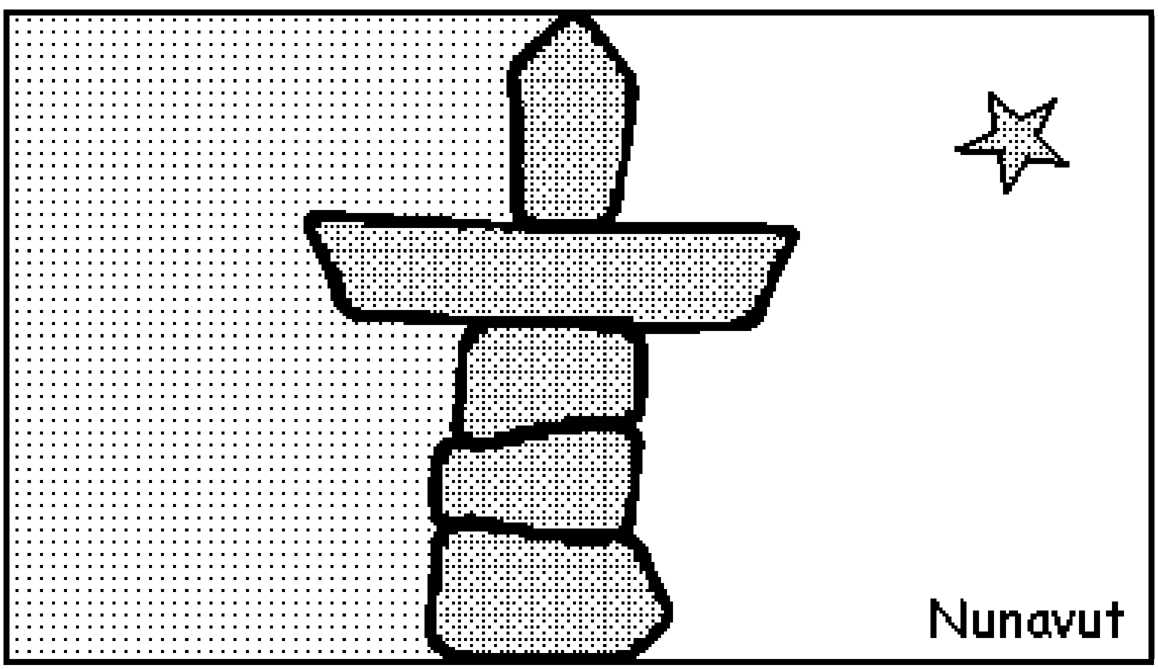

Argentina


Canada


Egypt


Ireland


New Zealand


Nunavut

NEW ZEALAND - AULKLAND

Auckland is found in the South Pacific nation named New Zealand. The islands of New Zealand are located about 1,600 km off the coast of Australia. You can expect abundant rainfall in New Zealand. The country receives 1,525 mm annually. In the North the mean annual temperature is 15 degrees Celsius. It is 9 degrees Celsius in the South. The average seasonal temperature range is about 10 degrees Celsius.

The country's latitude, its isolation, and its physical characteristics determine New Zealand's climate. The temperatures in New Zealand do not become extremely hot or cold.

It is normal to have days of fine weather followed by days of rainy weather. In the summer, you can expect longer spells of fine weather and intense sunshine. In the winter, blustery wet conditions increase. New Zealand has a chain of mountains that run down the centre of the country from North to South. This means the country's climate varies from West to East. In most parts of the country it is normally above 21 degrees Celsius in the summer. In the winter, it is normally above 10 degrees Celsius. Rainfall is normally 25-60 inches. Snow is common in the mountains but nowhere else.

IRELAND – CORK, COUNTY CORK

Ireland is a country located on an island next to Great Britain. No part of Ireland is located more than 110km from the sea. This means that the ocean influences the country's climate. The warm waters of the Gulf Stream moderate the country's climate. Parts of Ireland receive a lot of rain – about 2,500mm each year.

The temperature is about the same on the whole island. In January and February, the coldest months in Ireland, the temperature is about 4-7 degrees Celsius. In July and August, the temperature is about 14-16 degrees Celsius. The sunniest months in Cork are May and June. Ireland does not receive a lot of snow except in the mountains. Long-lasting snowstorms are rare.

EGYPT – ALEXANDRIA

Egypt is located in the northeast section of the African Continent. The Mediterranean Sea is located on its northern shore while Israel and the Red Sea are located to its east. The famous Nile River divides the country into two sections with 90 percent of the population of Egypt living in the river's surrounding area.

Egypt has only two seasons. Its winter is from November to March. Its summer is from May to September. Winters are cool and mild in the city of Alexandria. Temperatures range from 11 to 18 degrees Celsius in the wintertime. In the summer, the average temperature is 29. The annual rainfall in Alexandria is 175mm. Alexandria is located on the Mediterranean Sea. In Southern Egypt, people might expect only 2.5mm of rain per year! In fact, the coastal plain, along the Red Sea, is almost rainless.

ARGENTINA – BUENOS AIRES

Argentina, a South American country, lies south of Brazil. The ocean influences this country's climate. It has a number of different types of climates. A tundra climate exists in the high mountain ranges.

The lower regions have a cold monthly temperature of 10-18 degrees Celsius. Precipitation is moderate to light throughout the country. Thunderstorms, called pamperos, are common. In the winter, temperatures sometimes fall below freezing.

In the mountains, the average annual temperature is 10 degrees Celsius. Some of the highest mountain peaks have snow all year round. Some regions of the country are arid. In these regions, strong winds blow sands and create a continuous haze, which make it difficult to see.

Buenos Aires has hot, humid summers and cool, mild winters. In the summer time (December to February), the average temperature is 22-24 degrees Celsius. Rainfall is about 990mm. Buenos Aires receives snow very rarely.

BAKER LAKE – NUNAVUT

Nunavut, in Canada's Arctic, is by definition, a desert. At nearly 2 million square kilometers, it is one-fifth the size of Canada. You could fit approximately 36 Nova Scotias in Nunavut! Baker Lake is approximately 500 km north of Manitoba, and is the geographic centre of Canada.

The geography of Nunavut is varied, though generally rocky. The northern part of the territory is made up mainly of islands, and tends to be mountainous, with peaks more than 2000 metres tall, and many glaciers and ice fields. The southern part has many large lakes, and rocky coastlines with fjords (long narrow bays with high cliffs).

Because the Earth is tilted, the amount of daylight here varies dramatically. In Baker Lake some days only have four hours of sunlight in December, and twenty one hours of sunlight in June. The long winter lasts around nine months and temperatures can drop below -40°C. During this season, most of the waters are frozen over by a layer of ice generally less than two meters thick.

The polar waters, not far below, have a "warming" influence on the lower atmosphere. Baker Lake experiences extreme wind chill factors in the winter, causing temperatures to feel more like -50 to -60 degrees Celsius.

Things start to warm up near the end of April, as temperatures rise to between -15 and -20 degrees Celsius. During the brief summer, the waters still contain ice, so the air in contact with them is kept cool. Temperatures average around 15 degrees Celsius, though freezing temperatures do often occur between June and August.

Precipitation also varies significantly across Nunavut. Ellesmere Island receives only 50 mm per year, while southern Baffin Island receives nearly 400 mm. Precipitation generally falls as snow during the winter months from September until May. There are numerous blizzards throughout the fall, winter, and spring.

We have created or used some interesting inventions in our country to help us work and play. Here is an example of one such invention.

Tour Guides !

For more information about the climate in our country, please read the books below or try some of these web sites.

Paste a picture here which represents the type of climate visitors to your country can expect.

WELCOME TO

We think you will find the climate very interesting in our country because . . .

Here are some interesting facts about our climate.

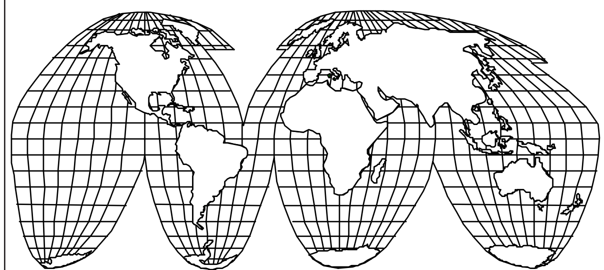
Temperature:

Precipitation:

Clouds and winds:

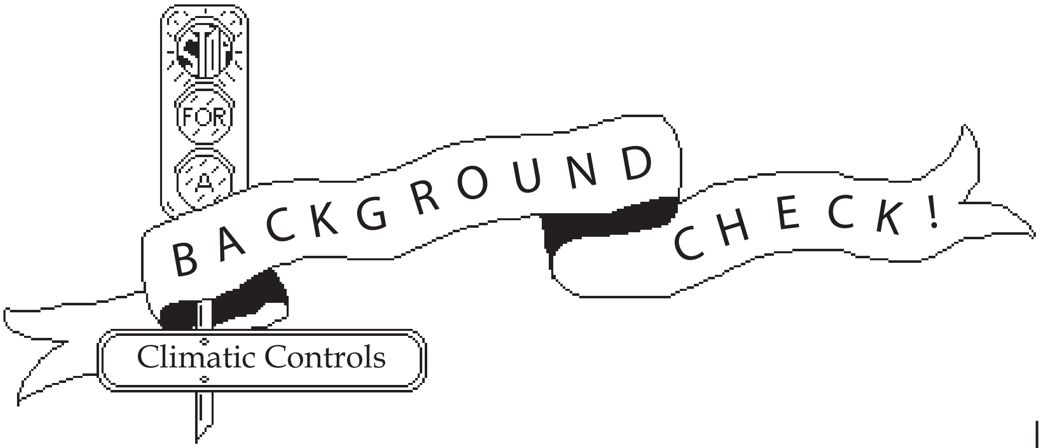
Other:

Where in the world are we?



Where in our country are we?

To be prepared for your trip to our country, you may want to wear the types of clothes and bring the types of items listed below.



The next two lessons look at two of the ways that natural phenomenon and geography affect climates.

Latitude and Sun Angle

If you can imagine the earth as a huge piece of graph paper, latitude refers to a given position on the Earth. This position is measured in degrees north or south of the equator. Latitude is said to be the most important climatic control. It influences the amount of energy available for the troposphere. The intensity of sunlight depends on the angle of the sun's rays as they arrive on Earth. The angle, in degrees, where the sun appears at a given time of day is known as the Angle of Incidence. The sun's energy arrives at the Earth's curved surface. This energy is concentrated in lower altitudes because of the Earth's tilt. Rays are *more spread* out at higher latitudes.

The following lesson entitled "Why is Temperature Greater Around the Equator?" is a demonstration of the effect created by changing the Angle of Incidence. The lesson only looks at one small aspect of the changing angle of sunlight and simplifies the concept for students to investigate. The numbers for the demonstration were chosen simply to create an easier calculation for the students while creating enough of a contrast between the two angles to hint at how a true difference could occur in Earth's system.

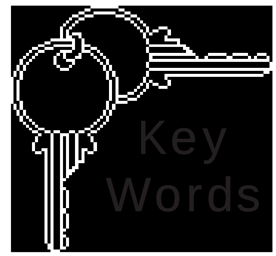
Distribution of Land and Water

Water is an efficient holder of heat but it takes a great deal of energy to change its temperature. When the sun shines on water, much energy is used in the evaporation of the water. As a result of this, large bodies of water can moderate air temperatures. Land on the other hand, heats up and cools off faster than water. For this reason, inland locations have greater temperature ranges.

In the upcoming lesson "Soil Versus Water: A Battle of Temperature Extremes", students explore this temperature range by recording the temperature changes in containers filled with either soil or water.

Altitude

The temperature in the troposphere decreases with altitude because absorption of reradiated long-wavelength infrared rays is most effective at the bottom of the atmosphere where the air is most dense. The air is continually warmed by the ground and by the ocean.



Sun Angle, Altitude, Orographic Barriers, Land and Water Distribution, Pressure Systems, Currents, Storms

Orographic Barriers (mountains)

When a highland, such as a mountain range, interrupts the surface of the troposphere, air must rise to bypass the barrier. As the air rises, it cools and is unable to hold as much moisture as before. This is why windward sides of mountains receive more precipitation than leeward sides. As the air then passes by the barrier, it descends, warms and is able to hold more water.

Semipermanent Highs and Lows

Seasonal high and low pressure systems influence the flow of air across large regions. These systems are called semipermanent highs and lows.

Ocean Currents

The surfaces of the world's oceans are in constant flux. Large circular movements, called gyres, circle the oceans in a clockwise and counterclockwise fashion. Water holds heat well so currents that flow away from the equator transfer heat to high altitudes. At the same time, the return current cools the air. Generally, cold ocean currents make coastal weather cool and dry. Warm currents generate warm, moist coastal climates.

Storms

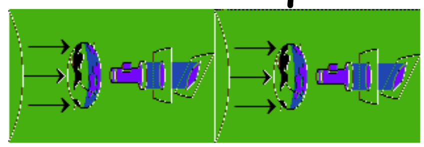
Storms occur in regular patterns around the world. Storms provide moisture and transfer heat.

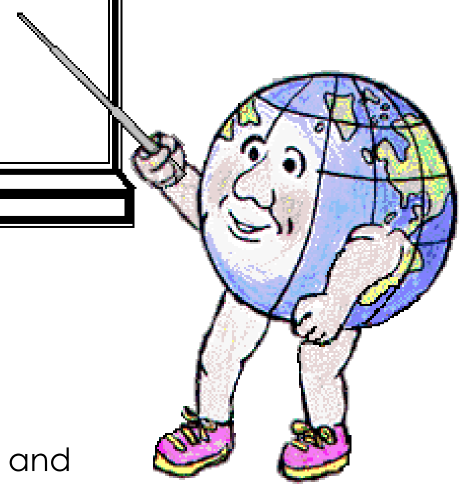
Source

Earth Science, A Holistic Approach Wm. C. Brown Publishers, 1994

Earth Sciences : Lesson #3

Why is Temperature Greater Around the Equator?





OBJECTIVES:

Students will be able to

- identify that the Earth receives direct and angled sunlight
- estimate area using graph paper
- name different cultures that lie on the equator or share the same latitude as Nova Scotia
- adapt temperatures into math equations
- describe why the Earth receives the most heat from the sun at the equator

MATERIALS:

7-8 flashlights, class set of worksheets, class set of rulers, calculators (optional), 2 different coloured pencil crayons for each student, globe, 3x226g bags of skittles (approx. 25 g per student in class).

PROCEDURE:

INTRODUCTION

Ask the students to remember the hottest and coldest temperatures they have ever experienced and then have them estimate what the warmest and coldest temperatures for Nova Scotia have been.

- The hottest temperature recorded was 38.9°C near Abercrombie Point, and the coldest was –41.1°C recorded in Upper Stewiack.

Then, have them estimate what the hottest and coldest temperatures recorded on Earth have been.

- The hottest was 58°C recorded in Al Aziziyah, Libya. The coldest was in Vostok Base Antarctica with a recorded temperature of –89.2°C.

Show the students where these places exist. Ask them if they can identify something unique about where the records were from. (Try to establish that one is near the South Pole and the other one is near the equator.)

Ask the students what type of climate they would expect around the two poles and which type around the equator.

Main Activity: Data Collection

Divide the children into as many groups as there are flashlights. Hand out one flashlight for each group and one activity sheet for each student (make sure each student also has a ruler).

Each student who was given a flashlight should shine the flashlight onto the activity sheet that belongs to the student to his or her right. The flashlight should be held approximately 15 cm directly over the first grid on the activity sheet ("Direct Sunlight"), pointing straight down onto the page. The shape, considering a standard flashlight, should be a circle. The student who's activity sheet it is, should trace the lit up area onto the grid. Have each student who has a flashlight, pass it to the student on the left and start the procedure again.

Make sure all flashlights are turned off and remain off until instructed to use them again. In the grid marked "Angled Sunlight", using a different coloured pencil, have the students draw their prediction of what area the light from the flashlight would produce if it were held at an angle. Demonstrate, without turning the flashlight on, by holding the flashlight 15 cm away and at a 45° angle from the centre of a sample activity sheet.

After the students have drawn their predictions, have them turn on the flashlights and record the actual data from a flashlight held 15 cm away and at a 45° angle from the grid marked "Angled Sunlight". Use the same procedure as before for having neighbours hold the flashlights.

Data Analysis: Skittles

Hand out approximately 24 Skittles to each student. Have students fit as many Skittles as they can side by side within the shape made by the direct sunlight data. They are to record the number below the 1st grid on the worksheet in the box labeled "Number of Skittles". All extra Skittles should be removed from desk, or better yet, eaten.

The students now move all the Skittles used in the upper grid down into the lower grid. Tell them to spread the candies out evenly within the shape made by the angled sunlight without adding any new candies to it. Ask them the following questions.

What is different between the two arrangements of candies?
Why is there such a difference?
What does this have to do with sun angle?

AREA

Have the students colour all the complete grid squares in the two data collection shapes that are entirely within the shapes outlined. In other words, the shapes' outlines do not dissect the coloured squares in any way. Record the number on the activity sheet in the appropriate "Number of full blocks" square.

Using a different coloured pencil crayon, the students can now colour all remaining block pieces that are within the shapes' outlines. Those partial blocks should be counted, the number divided in half and recorded in the next set of squares marked "Half the number of partial blocks". If the number of partial squares is an odd number the students can round it up to the next even number. This will ensure a whole number when it is halved. The "Approximate area" data can now be calculated by adding the two squares above. Use this opportunity to discuss why approximate values are sometimes used instead of exact figures.

Take suggestions from the class as to how the comparison of the two areas would help explain the affect of sun angle on temperatures and climates.

TEMPERATURE COMPARISON

Pose this question to the class. If each Skittle was one packet of sunlight, and each packet was 40°C, what temperature would a block be in the direct and then the angled sunlight situations? Take estimates from the class. Have them calculate their own data (with or without a calculator) by copying the "Approximate area" data into the box labeled "Approx. Area" and completing the calculation to fill in the remaining "Temp. of One Block" square. The calculation is:

(Number of Skittles)	x 40°C	÷	(Approx. Area)	=	(Temp. of Block °C)

Compare the predicted amounts to the results. Ask if the results back up what was believed previously about sun angle. Therefore which climate would be hotter, one with direct sunlight or one with angled sunlight.

APPLICATION

Ask the students if they know of any culture that lives where the sun's rays arrive at approximately a 45° angle. Give the class a hint by telling them that Stewiack, Nova Scotia is half way between the equator (0°) and the North Pole (90°). Point out that Nova Scotia is itself around the 45° latitude mark and therefore the sun's light also arrives at a 45° angle on average.

Have each student, using the classroom world map, find a country either along the equator, 45° N of the equator, or 45° S of the equator. Each student is to take turns going to the map and picking a country that has not yet been picked. They write the name of the country on a "Post-It" note and stick it to the location on the map to claim that country as their choice. They then write their countries name in the appropriate spot on the teacher's overhead that is divided up like the following diagram.

45° North
0°
45° South

CONCLUSION:

This information can be used by the class for a concluding discussion as to whether the concept of latitude and sunlight angle is accurately demonstrated in the data by what is commonly known about the climate of the mentioned countries. The class should try and come up with other reasons for climate differences between countries that share the same latitudes.

Additional Activities

Mathematics:

- Have the students use fractions to get a better area calculation.
- Take suggestions on a more accurate way of calculating the area.
- The students could try converting Celsius to Fahrenheit and vice-versa.

Language Arts:

- Journal entry about the hottest or coldest day they remember.

Health:

- Review use of sunscreen and why the noon hour is the worst for burns.

Geography

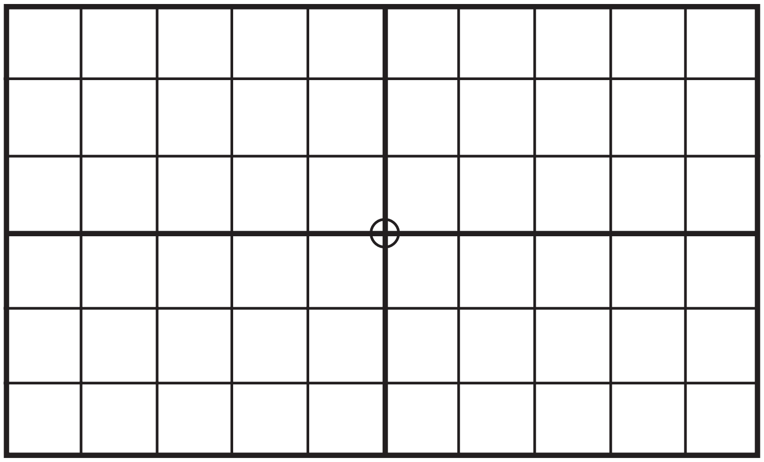
- Have a list of countries and students must find out if they are near the North Pole, South Pole, or Equator.

Sun Angle Activity Sheet

Name : ______________________________

Date : _____________

Direct Sunlight



Number of full blocks = ☐

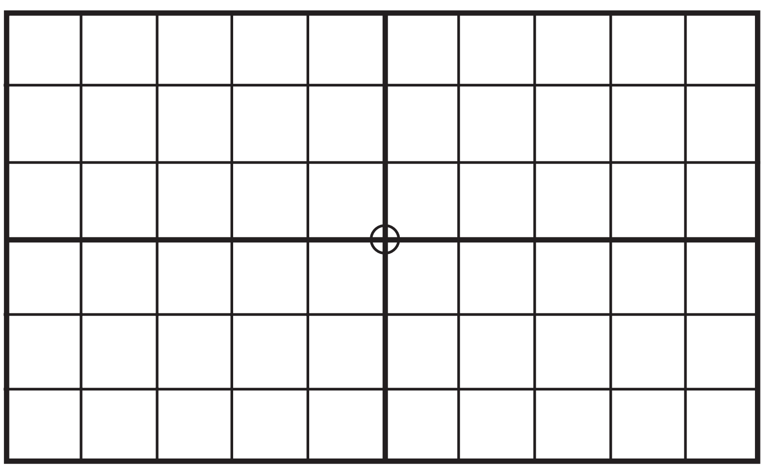
Half the number of partial blocks = ☐

+

Approximate area = ☐

Number of Skittles		°C		Approx. Area		Temp. of One Block
☐	X	40	÷	☐	=	☐ °C

Angled Sunlight



Number of full blocks = ☐

Half the number of partial blocks = ☐

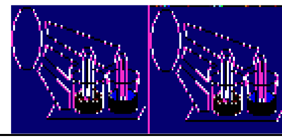
+

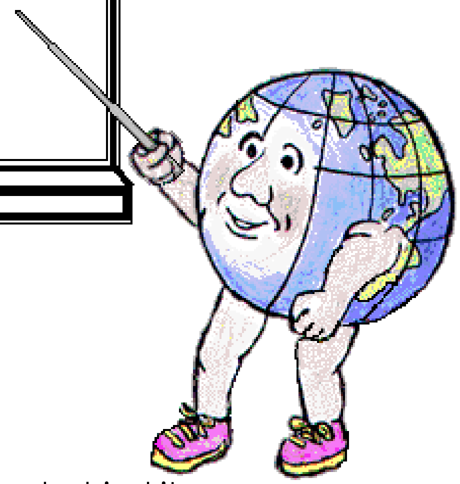
Approximate area = ☐

Number of Skittles		°C		Approx. Area		Temp. of One Block
☐	X	40	÷	☐	=	☐ °C

EARTH SCIENCES : LESSON #4

Soil Versus Water: A Battle of Temperature Extremes





OBJECTIVES:

Students will be able to

- use a thermometer to collect data
- predict a trend and theorize the reason behind it
- connect science to real life situations

MATERIALS:

2 containers per group, enough top soil and water to fill containers 5 cm deep, 2 thermometers per group, class set of activity sheets

PROCEDURE:

INTRODUCTION:

Ask the students if, during the summer, it is hotter along the shorelines then inland. Show them Nova Scotia's temperature data from the summer. Ask them if during the winter it is colder along the shoreline then inland. Show them Nova Scotia's winter data. Take suggestions as to why shorelines are cooler than inland during the summer yet warmer than them during the winter.

MAIN:

Divide the class into groups and give each student a data-recording sheet and give each group a container of topsoil, a container of water, and 2 thermometers.

- WARNING: Thermometers may break causing the danger of both mercury poisoning and cuts from broken glass. Warn students to be extra careful with them and not to go near them if any break.

Instruct each group to place the thermometers into the containers, wait 2 minutes, and then put the containers into direct sunlight. Record the initial temperature and then the temperature at every half-hour mark for an hour and a half. Ask the class if they can tell you what type of chart the data will resemble (bar graph).

- NOTE: At each half-hour interval, only one student in each group is needed to collect the data. They can alternate data collectors within each group every half-hour and then pool their data at the end.

Move the containers into a shaded area and repeat the procedure by using the last recorded temperature for the sunlight data as the initial temperature for the shaded data.

CONCLUSION:

Ask the students which material they believe was the best at holding its temperature and how did they come up with that theory. Ask them which material dropped the most in temperature in the shade. If water keeps its temperature longer, why are shorelines benefiting? Explain that winds blow over the water and are cooled or warmed by it. The winds then blow over the land, cooling or warming it. Therefore, in the winter, the water still has some of its summer heat. The winds coming over the water end up warming the land. The opposite is true for the summer.

End with a discussion on the following question. If the world's average temperature increased, where would the biggest increases be?

ADDITIONAL ACTIVITIES

MATHEMATICS:

- Compare the temperature changes between intervals and use that to try and predict what the temperature will be for the next interval.

LANGUAGE ARTS:

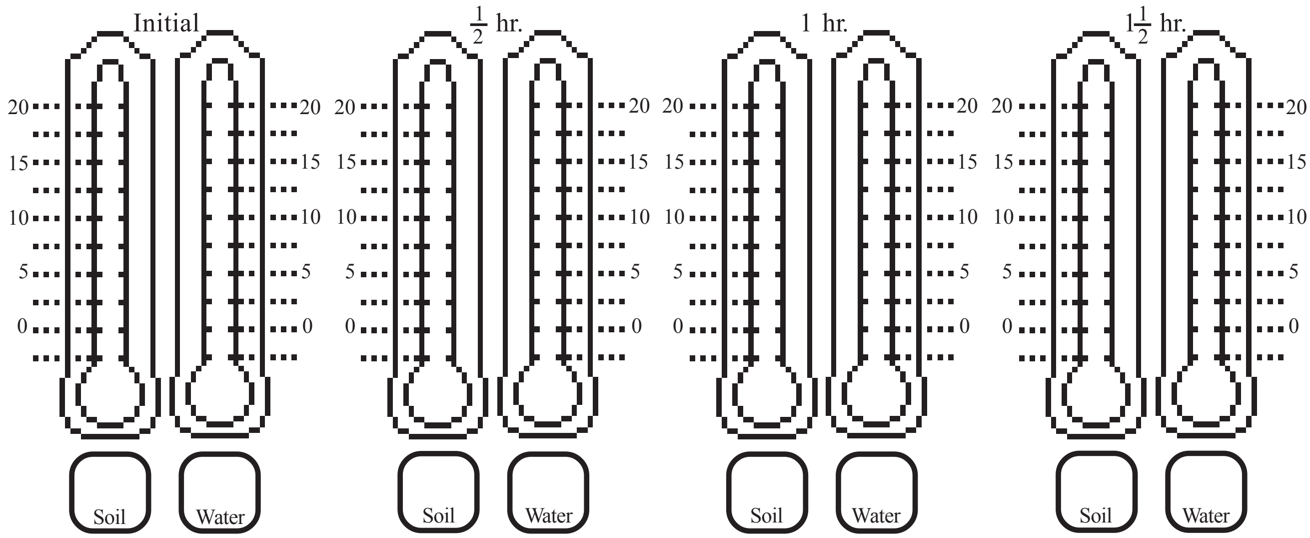
- Have the students write a picture poem. Have them brainstorm descriptive words about shorelines and fashion the words to make a picture of a beach ball, shell, sand pail, or anything else shoreline related.

Soil Vs. Water Activity Sheet

Name : ______________________________

Date : _____________

Direct Sunlight



SOIL

$1\frac{1}{2}$ hr. — Initial = Temp. Change

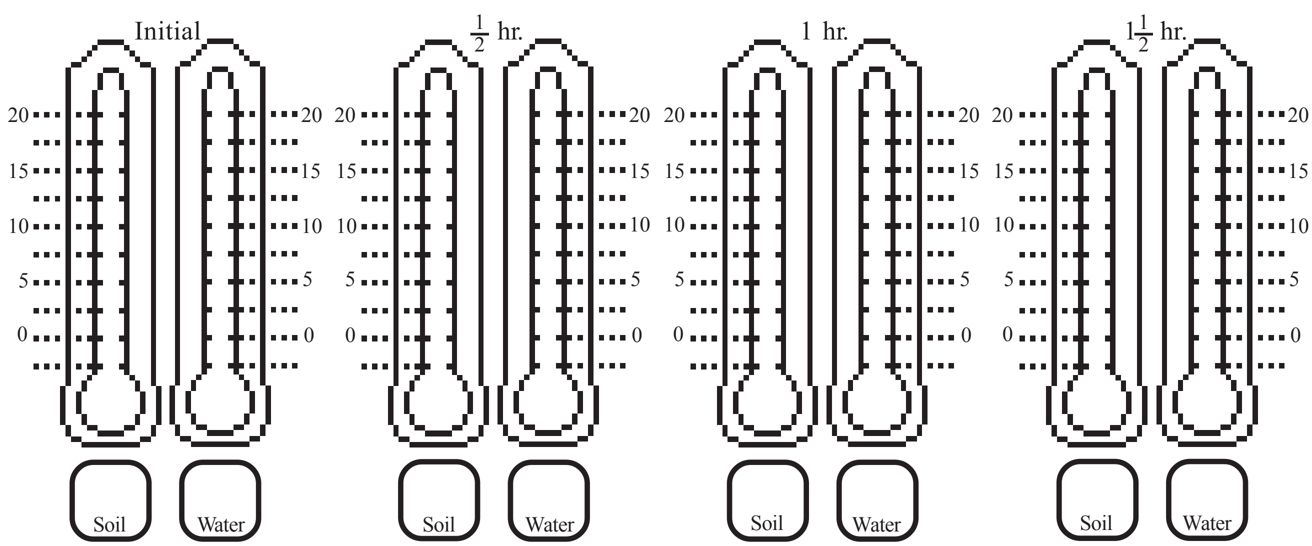
☐ °C – ☐ °C = ☐ °C

WATER

$1\frac{1}{2}$ hr. — Initial = Temp. Change

☐ °C – ☐ °C = ☐ °C

Shaded Area



SOIL

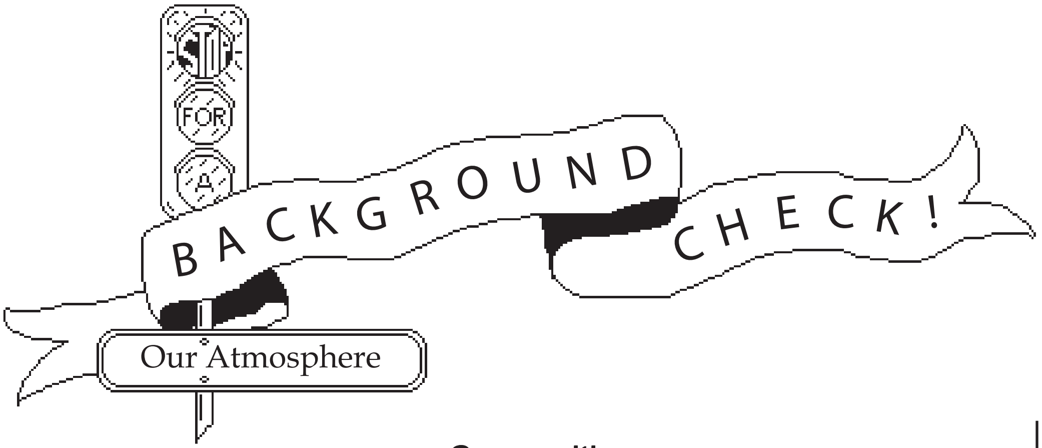
$1\frac{1}{2}$ hr. — Initial = Temp. Change

☐ °C – ☐ °C = ☐ °C

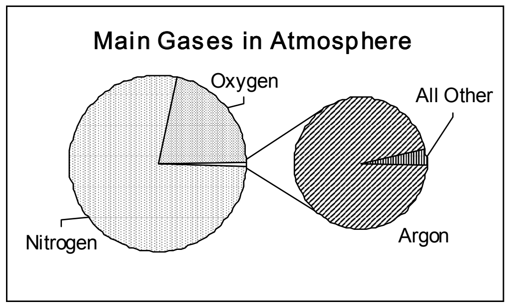
WATER

$1\frac{1}{2}$ hr. — Initial = Temp. Change

☐ °C – ☐ °C = ☐ °C

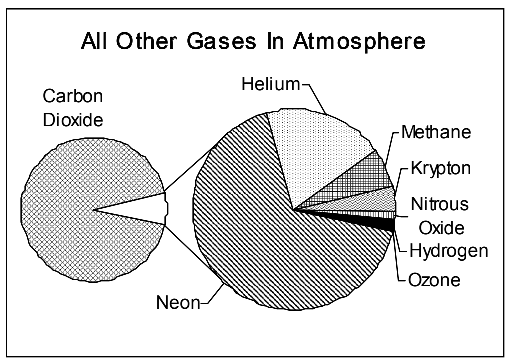


Composition



Main Gases in Atmosphere:

Nitrogen 78.08%
Oxygen 20.95%
Argon 0.93%
All Other Gases 0.04%



All Other Gases in Atmosphere:

Carbon Dioxide .036%
(This is increasing as a result of human activities.)
Neon .0018%
Helium .00052%
Methane .00017%
Krypton .00011%
Nitrous Oxide .00003%
Hydrogen .00005%
Ozone .0000002% (variable)
Water Vapour (variable)

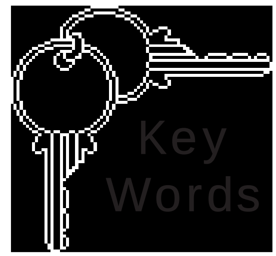
Thermal Layers of the Atmosphere

The earth's atmosphere is divided into four thermal layers. These are the troposphere, the stratosphere, the mesosphere and the thermosphere.

Troposphere (0-10km):

Almost all of Earth's weather occurs in the troposphere, which also contains nearly all of the atmosphere's water vapour. This layer of the atmosphere extends to variable altitudes of 10-20km. The top of the troposphere, called the tropopause, is about 15-20km at the equator and 10km at the poles. At a latitude of about 40 degrees, the troposphere decreases sharply. This sharp change in incline gives rise to the jet stream.

The temperature in the troposphere decreases with altitude because absorption of reradiated long-wavelength infrared rays is most effective at the bottom of the atmosphere where the air is most dense, and because the air is continually warmed by the ground and the ocean. The troposphere is continually convecting with warm ground-air rising and cooler air sinking.



Atmosphere, Composition, Thermal Layers, Troposphere, Stratosphere, Mesosphere, Thermosphere, Clouds

What do we find in this layer?

- Most of Earth's weather
- Mount Everest (8.878km)
- Small and medium sized aircraft (Commercial jet liners fly in the upper troposphere "above the weather")
- Jet stream (rivers of air that influence weather)
- Clouds Stratus (under 330m), Cumulus (450m-3km)
  Altocumulus (about 5km), Cirrus (about 9km)

Stratosphere (15-47km):

The stratosphere lies above the troposphere. In this layer, temperature increases with altitude because ozone concentration increases at higher levels and absorbs ultraviolet rays and converts them into heat energy. The upper boundary of the stratosphere is called the stratopause.

What do we find in this layer?

Ozone, a gas that absorbs harmful ultraviolet rays
High altitude meteorological balloons
Mother of Pearl Clouds
Radiosonde balloons – one type of high altitude meteorological balloon
Some commercial jets fly in the lower stratosphere

Mesosphere (47-80km):

In this layer, the temperature decreases with height. The air is very thin.

What can we find in this layer?

Radiowaves, Military aircraft, Ozone layer

Thermosphere (80-500km):

The thermosphere is a region of increasing temperature. The temperature at the top of the thermosphere may reach as much as 1500 degrees Celcius. This temperature does not mean that the atmosphere is hot, however. There are very few gas molecules present in this layer so there is little heat despite the high temperature. Parts of the thermosphere and mesosphere contain electronically charged particles. This layer is known as the ionosphere.

What can we find in this layer?

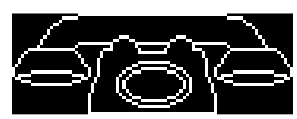
The Northern Lights (the Aurora)

When radiation from the Sun is absorbed by molecules of gas in the thermosphere, some of the molecules are broken apart to form electronically charged ions. Auroras appear when electrons streaming in from the sun combine with ionized gases, form neutral atoms, and give off light rays in the process.

Military satellites
Meteorological satellites
Meteors
Noctilucent clouds

These are very high clouds luminated at night by the sun's rays even though the sun is below the horizon.

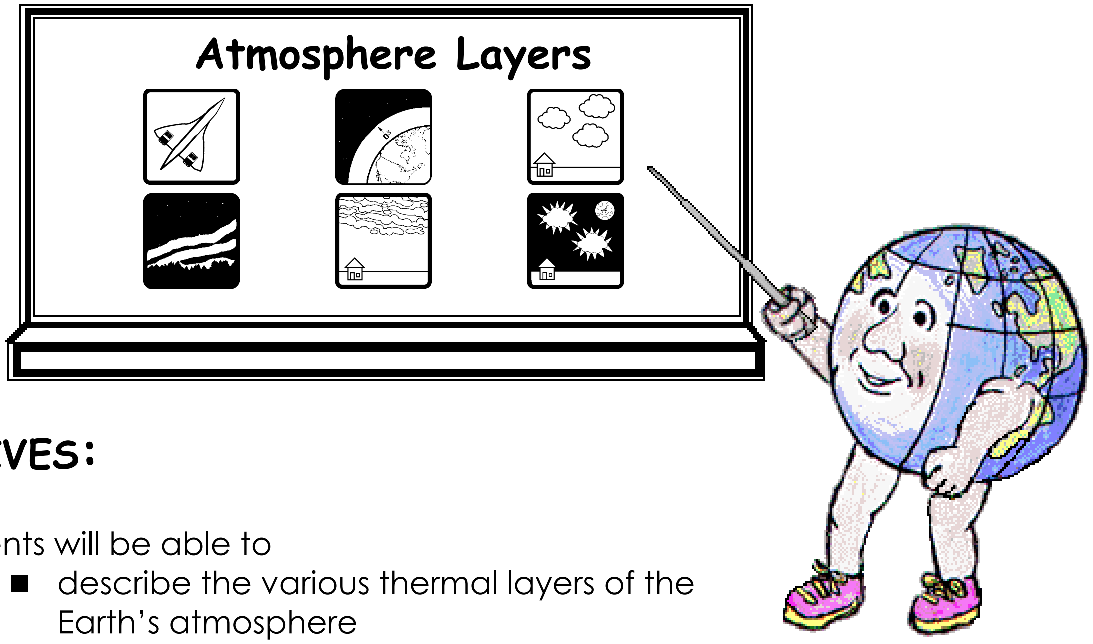
International Space Station (400km)



Contact

For fun tracking satelites and the International Space Station, visit
http://spaceflight1.nasa.gov/realdata/sightings
and
http://heavnens-above.com

Earth Sciences : Lesson #5



OBJECTIVES:

Students will be able to

- describe the various thermal layers of the Earth's atmosphere
- describe the different types of human-made and natural objects found in each of these thermal layers
- examine the relative distances of the various thermal layers

MATERIALS:

Large roll of paper, markers, tape, atmosphere icons, template of atmosphere layers, children's books on atmosphere and space

PROCEDURE:

INTRODUCTION

Brainstorm ideas with students of objects they may find high in the sky. Show and explain to the class the icons and what they represent. Have the class guess where in the atmosphere that these objects might be found. Explain that the atmosphere around the Earth has layers. Draw a diagram on the board or bring in an onion to demonstrate this idea.

Explain that the class will be working together to construct a classroom model of the Earth's atmosphere. Show the class the outline of the Earth's layers on an overhead. Have the class brainstorm the best way to show these layers as a model on the wall.

Main Activity

Divide the students into five groups. Assign four of the groups to research each of the four atmospheric layers. Assign a fifth group to draw and measure the layers of the atmosphere on large newsprint that you have placed on the wall. Have them draw the layers to scale with the smallest layer being at least 20 centimeters high. The top of the Thermosphere does not have to exist on the chart paper but have the students tape a paper line on the ceiling where it would end if they continued to measure the layer up the wall and along the ceiling.

In each group of researchers assign the following positions:

- Two students will research the atmosphere layer and record interesting facts in the appropriate spot on the wall. They can also decorate this layer.
- Two students will look for information about the icons to find out where they should be placed on the wall. These students can decorate the icons that fall in their layer of the atmosphere. They can also write interesting facts and place it on the wall next to their atmosphere layer.
- One student will be responsible for obtaining and sharing relevant information with other groups. This student (or another if preferred) could prepare a presentation for the class as well.
- If the group that was assigned to draw the layers is finished early, they can be reassigned to the various research groups. They could also help with the planning of the class presentations.

Encourage the groups to share information. Remind them that good research is often conducted in large teams with everyone playing an important role. Have the students present their layers and icons to their classmates. The final chart could be used as a hall display of their work.

Conclusion:

Through a class discussion the students can recall their original predictions about the atmosphere layers and reveal misconceptions that they have since corrected. Have a member from each layer point out the most unique thing that they discovered about their section of the atmosphere, and the most unique thing that they learned from hearing the other presentations. Share your own discoveries with the class as well.

ADDITIONAL ACTIVITIES

MATHEMATICS:

- Students can explore more aspects of drawing to a specific scale by creating a wall size version of the Troposphere. Students can create scale versions of different natural and human made items on Earth. If the object is something like the C.N. Tower, remember to calculate the height of the C.N. Tower (how long to make your cut-out) and how high above sea level Toronto exists (how high on the Troposphere scale to place the base of the cut-out)

HISTORY:

- Students can look into the historical development of inventions by humans that led higher and higher within the atmosphere, leading to the present creation of the International Space Station.

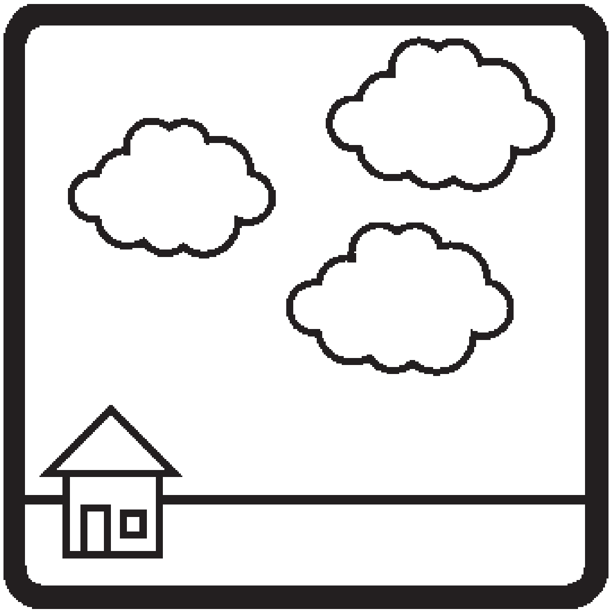
Earth's Atmospheric Layers

Thermosphere
80-500km

Mesosphere
45-80km

Stratosphere
10-45km

Troposphere
0-10km

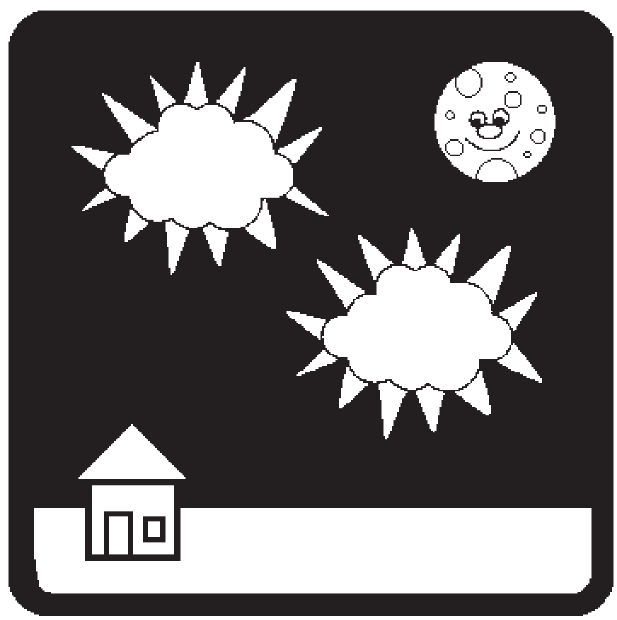


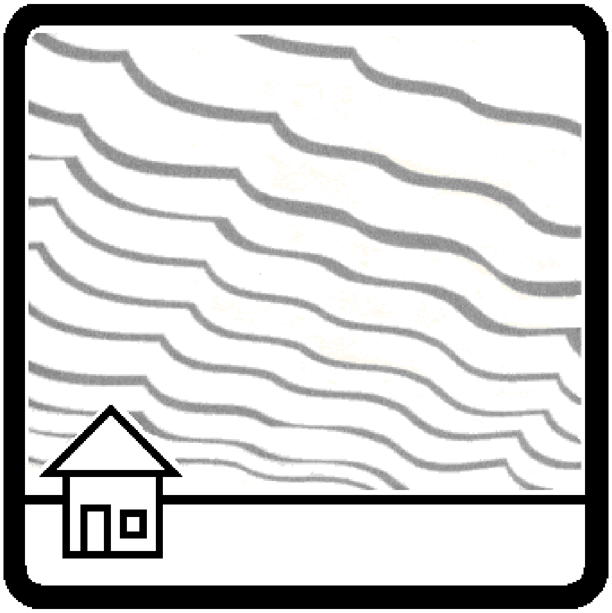
Cumulus
Clouds

Altocumulus
Clouds

Cirrus
Clouds

Noctilucent
Clouds

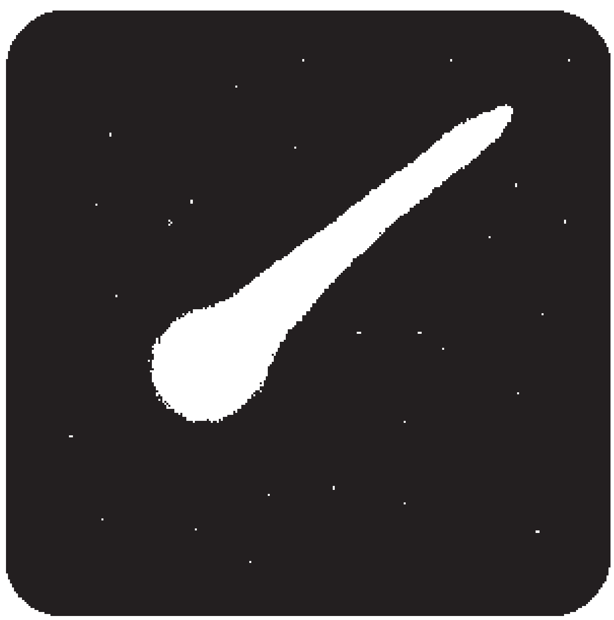


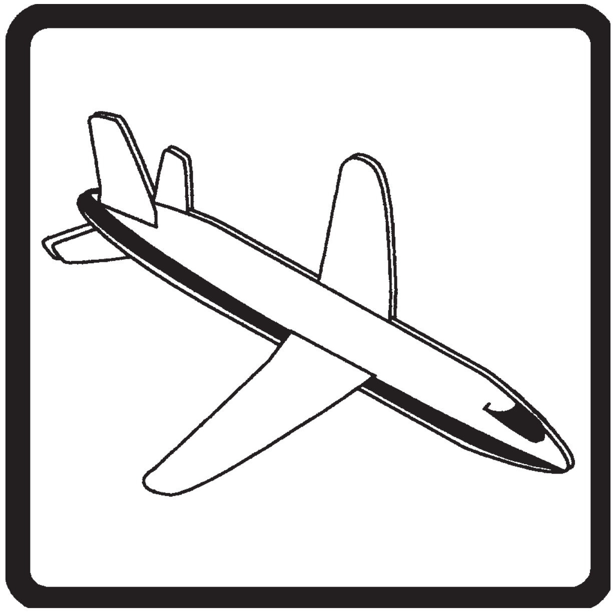


Stratus
Clouds

Aurora Borealis,
The Northern Lights

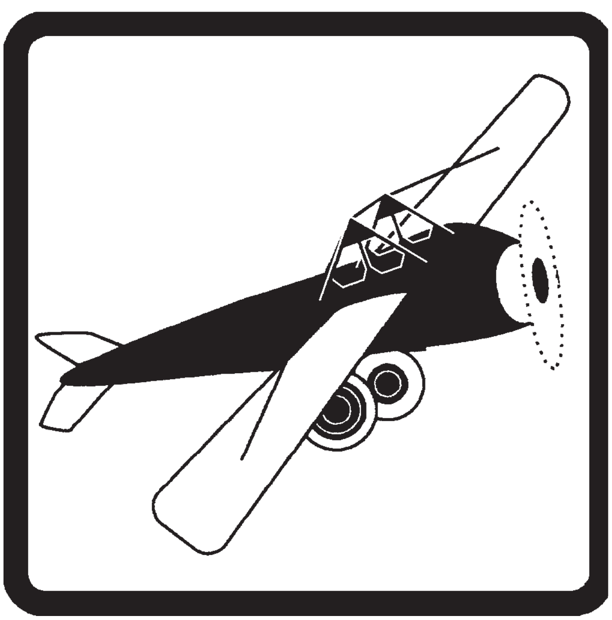
Meteor



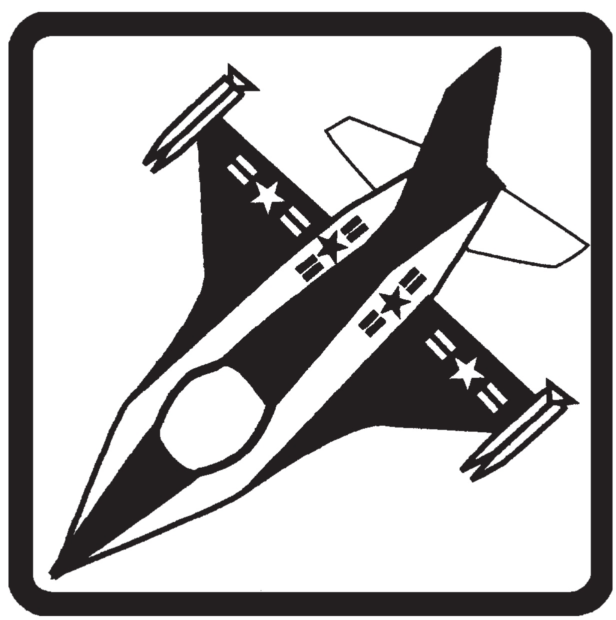


Jet

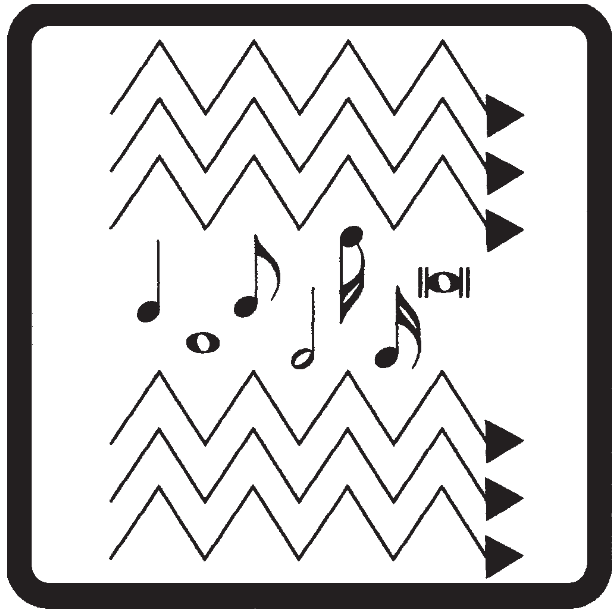
Small Aircraft



Military Aircraft

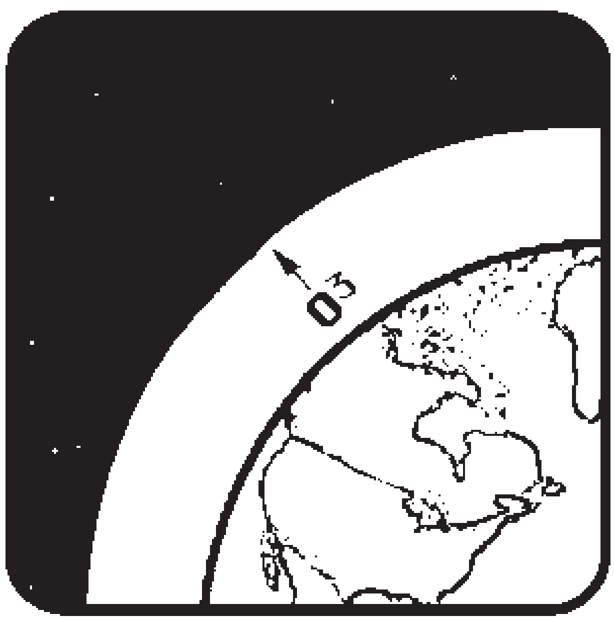


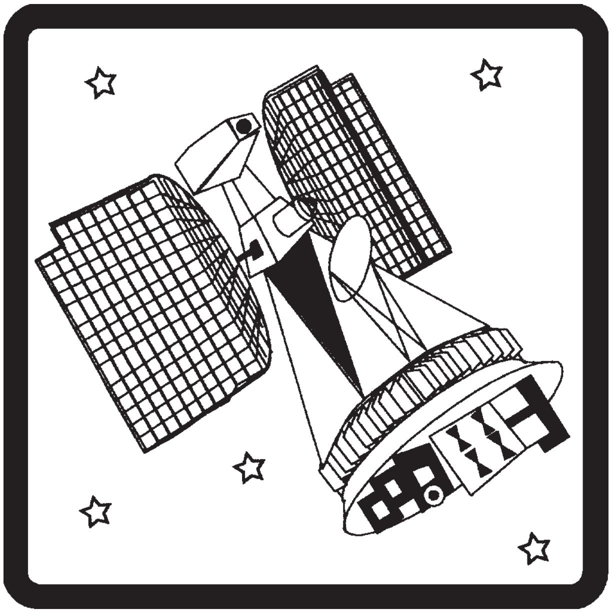
Mount Everest



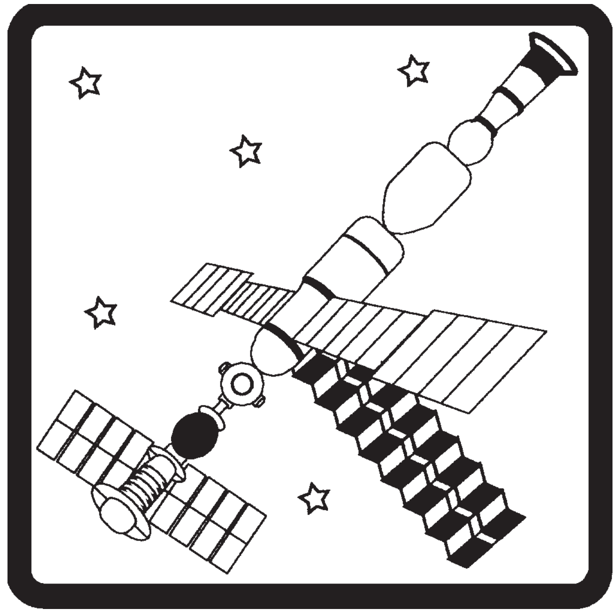
Radio Waves

The Ozone Layer



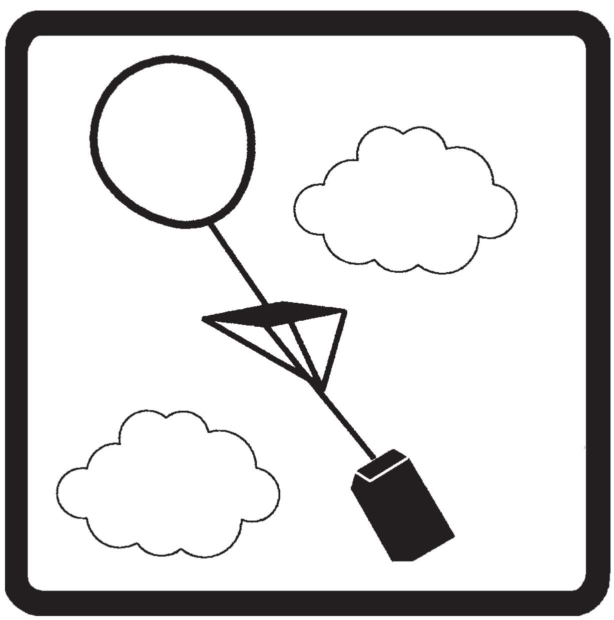


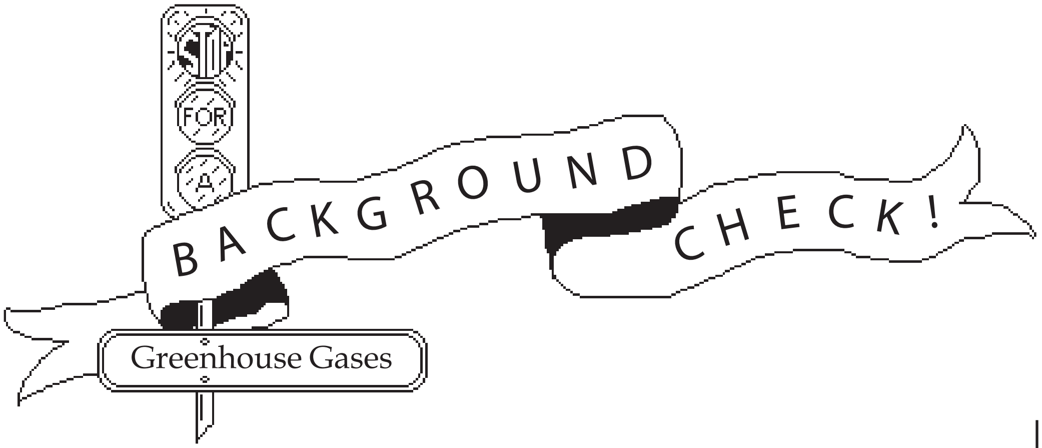
Meteorological Satellite



Space Station

Weather Balloon





What are they and where do they come from?

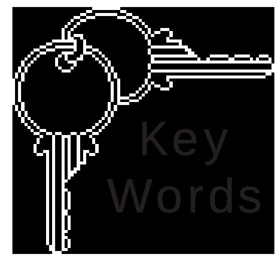
All greenhouse gases (except CFCs) occur naturally in the lower atmosphere. Remember that these gases control energy flows in the atmosphere by absorbing heat. It's hard to believe that these trace gases comprise less than 1% of the atmosphere yet play such an important role. The level of these gases in the atmosphere is determined by a balance between *sources* and *sinks*. Sources are processes that generate greenhouse gases. Sinks are processes that destroy or remove them from the atmosphere. Humans affect greenhouse gas levels by introducing new sources or by interfering with natural sinks.

Water Vapour

The largest contributor to the natural greenhouse effect is water vapour. Its presence in the atmosphere is not directly affected by human activity. Nevertheless, water vapour matters for enhanced climate change because of an important *positive feedback*. Warmer air can hold more moisture, and models predict that a small global warming would lead to a rise in global water vapour levels, further adding to the enhanced greenhouse effect. On the other hand, it is possible that some regions may become drier. Modeling of climate processes involving clouds and rainfall is particularly difficult so the exact size of this crucial feedback is unknown.

Carbon Dioxide

Carbon dioxide is currently responsible for over 60% of the *enhanced* greenhouse effect. This gas occurs naturally in the atmosphere but carbon dioxide produced by human activity also enters the natural carbon cycle. Burning coal, oil, and natural gas releases the carbon stored in these *fossil fuels.* Likewise, deforestation releases carbon stored in trees. Current world annual emissions amount to over 7 billion tonnes of carbon, or almost 1% of the total mass of carbon dioxide in the atmosphere. Many billions of tonnes of carbon are exchanged naturally each year between the atmosphere, the oceans, and land vegetation. The exchanges in this massive and complex natural system are precisely balanced. In fact, carbon dioxide levels appear to have varied by less than 10% during the 10,000 years before industrialization. In the 200 years since 1800, however, levels have risen by almost 30%. Even with half of humanity's carbon dioxide emissions being absorbed by the oceans and land vegetation, atmospheric levels continue to rise by over 10% every 20 years.



Greenhouse Gases, Sources, Sinks, Carbon Dioxide, Methane, Nitrous Oxide, Water Vapour, CFCs, Aerosols

Methane

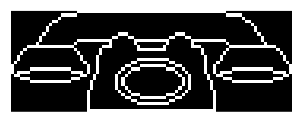
Methane (CH4) is a powerful greenhouse gas. While some of the methane in the atmosphere is produced naturally, by wetlands for example, the majority is a result of human activities. Methane is emitted by some agricultural practices, in particular from livestock and rice paddies, from industrial sources, and from burning fossil fuels and biomass. The abundance of methane in the atmosphere increased in abundance during the 1970's and the 1980's, but rates of increase have decreased significantly since the 1990's. Between 1999 and 2005, growth rates of atmospheric methane were close to zero. This is likely a result of the atmosphere approacting equilibrium. Methane has an effective atmospheric lifetime of only 12 years, whereas carbon dioxide survives much longer. This means that the relative importance of methane versus carbon dioxide emissions depends on the time horizon . For example, methane emitted during the 1980s is expected to have about 80% of the impact of that decade's carbon dioxide emissions over the 20–year period 1990–2010, but only 30% over the 100–year period of 1990–2090.

Nitrous Oxide, Chlorofluorocarbons (CFCs), and Ozone

Nitrous oxide, chlorofluorocarbons (CFCs), and ozone are responsible for the remainder of the enhanced greenhouse effect. It is estimated that 40% of current nitrous oxide emissions are from human activities, such as intensive agriculture. Chlorofluorocarbons, or CFCs, increased rapidly until the early 1990s, when they were phased out of use under the tough emission controls introduced with the Montreal Protocol to protect the stratospheric ozone layer. Atmospheric levels of some CFC's are not decreasing due to natural removal processes. Ozone is another naturally-occurring greenhouse gas whose levels are rising in some regions in the lower atmosphere due to air pollution. Be careful not to confuse lower level ozone with the decline of ozone in the stratosphere, known as the decrease in the ozone layer.

Aerosols

Aerosols are not gases, but rather small particles present in the atmosphere. They contribute to the greenhouse effect through the reflection and absorption of infrared radiation in the atmosphere. That is, they cool the climate locally by scattering sunlight back into space, blocking sunlight directly and also providing "seeds" for clouds to form. Aerosols come from natural source, such as mineral dust, sea salt, and volcanic explosions, as well as from human activities such as the burning of fossil fuels and biomass, surface mining, and industrial processes. Aerosols settle out of the air after only a few days, but they are emitted in such massive quantities that they have a substantial impact on climate.



Source

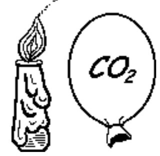
Climate Change 2007: The Physical Science Basis United Nations Intergovermental Panel on Climate Change

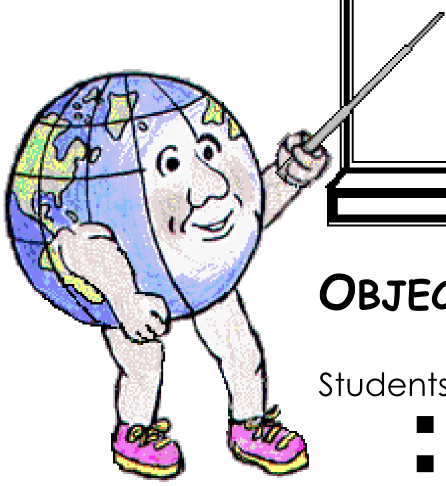
United Nations Environment Program Climate Change Information Kit

UN Environment Programme's Information Unit for Conventions

Earth Sciences : Lesson #6

Shedding a Light on Carbon Dioxide





OBJECTIVES:

Students will be able to

- demonstrate that the air is made of different gases
- demonstrate that gases have weight and take up space

MATERIALS:

Overhead (atmospheric gases pie chart), a box of baking soda, a bottle of vinegar, a measuring cup, a short candle (5cm tall), a plastic or glass cup with sides about 2.5cm taller than the candle, a glass wine bottle, tablespoons, hole punches

<u>For each group of students:</u>

A glass bottle (wine/beer bottle or something similar), 2 easily inflatable balloons, a cardboard triangle, a cardboard strip 25cm x 4cm, lightweight string (20cm), bendable fasteners (used as center joint for a balance), 2 small cups or containers, a ruler

PROCEDURE:

INTRODUCTION

Explain to the students that the atmosphere is made up of many different gases. Show them the pie chart. Discuss how gases occur naturally in the atmosphere but are also made by humans. Brainstorm possible sources and uses of these gases. Tell the students that they will be making one of these gases – carbon dioxide.

Explain to them that this gas occurs naturally in the air. Plants use this gas to carry out their everyday functions. Humans also produce this gas by some of the actions that they perform such as breathing, or burning fossil fuels and trees. Explain that a good way to make carbon dioxide is to mix vinegar and baking soda. Ask them why this might be useful in the kitchen.

MAIN ACTIVITY :

TEACHER DEMONSTRATION:

Light the candle and place it in the cup on a table. Next to the candle, place the empty bottle. Measure 100ml of vinegar and pour it into the bottle. Use a funnel made from a piece of paper to add 4 heaping tablespoons of baking soda into the bottle. Have students make observations on their question sheet.

Pick a volunteer to place their finger on the top of the bottle and then describe to the class what they noticed. Tip the opening of the bottle over the lit candle flame as if you were about to pour something onto the candle. In this way, you are *pouring* the gas onto the flame. The carbon dioxide should fill up the candle's container, block oxygen from reaching the flame, and the flame should die out. Have the students record their observations in their table. Discuss reasons for the extinguished flame.

STUDENT ACTIVITY:

The students should be divided into groups depending on availability of materials. They should then follow the given instructions on the "Student Activity Instructions" sheets provided. It starts with them creating a balance. Then each group fills a balloon with carbon dioxide by placing it over the mouth of a bottle that contains baking soda and vinegar. The balloon should be inflated to approximately 8 or 9cm in diameter. The students then tie off the balloons and attach them to the balance along with a balloon that has not been inflated. Observations are made as to how the balance compares the weight of the two balloons.

NOTE: If you predict that students in your class may have difficulty tying their own balloons and you do not want them all asking for help to tie them, have twist ties available. Remind the students to be careful not to pop the balloon and to include a twist tie for the non-inflated balloon. Have the class explain why the non-inflated one needs the twist tie in order for the results to be valid.

CONCLUSION:

After the students have completed their experiment, cleaned up their group's materials, and completed all but the final question on the Student Experiment Question sheet, have the students share their observations and reasoning with the class. They can now complete the question sheet.

Additional Activities

Health Science:

- Students can look into adapting the experiment by using exhaled carbon dioxide to fill the balloon and compare it to the one filled by the carbon dioxide given off by the baking soda and vinegar. This could lead to discussions on lung capacity and the respiration process. Health issues like smoking can be easily included.

Mathematics:

- If there is an actual precise scale available, the experiment could be done for the class. Students could collect the data off the one scale and calculate how much the scale says that the gas in the balloon weighs.

Teacher Demonstration

Briefly record the steps in your teacher's experiment.

What did you notice when your teacher tipped the bottle over the candle?

Why do you think this happened?

What kind of gas was made when your teacher added the baking soda to the vinegar?

What are some other ways that human activities can make this kind of gas?

Student Experiment

What happened to the balloon when you placed it over the neck of the bottle?

Explain why this happened.

What did you collect in the balloon?

What happened when you put the second balloon onto the balance?

Give reasons for your findings.

Did your classmates have the same observations? Why do you think they might have different observations?

Student Experiment Instructions

Name: ______________________________

Materials List

- ○ empty bottle
- ○ 100ml vinegar
- ○ cardboard triangle
- ○ lightweight string
- ○ bendable fastener
- ○ 22cm x 4cm cardboard strip
- ○ 4 tablespoons baking soda
- ○ 2 balloons
- ○ ruler

Procedure:

1. Collect the material listed above and check them off once you have them at your desk.
2. Punch a hole in exactly the centre of the cardboard strip using a hole punch that will be shared amongst the class.
3. Punch two holes at each end of the strip. Make sure they are both the exact same distance from the ends.
4. Attach the strip of cardboard to the triangle with the bendable fastener so it looks like a teeter-totter.
5. Carefully cut two pieces of string that are the same length (10cm).
6. Tie one of these strings to a deflated balloon and attach it to one end of the balance through the hole you punched.
7. Put the balance aside for the time being.
8. Stretch a second balloon by completely inflating it twice while letting the air out each time. Do not tie a knot in it.
9. Carefully pour the 100ml of vinegar into the bottle.
10. Use a piece or paper shaped into a funnel to add the baking soda and then wait no longer than a second.
11. Quickly but carefully, place the stretched balloon over the neck of the bottle.
12. When the balloon reaches aproximately 8 or 9cm in diameter (or 5 min. have passed), carefully remove it and tie it without letting any air out. What happened to the balloon?
13. Record your observations by answering the first three questions on the "Student Experiment" section of the question sheet.
14. Use the string that you cut to attach the balloon to the opposite end of the balance from the deflated balloon.
15. Ensure that the inflated and deflated balloons are the same distance from the centre of the balance.
16. Observe how the balance reacts. Complete the fourth and fifth questions on the "Student Experiment" section of the question sheet.

BACKGROUND CHECK!

Natural Greenhouse

With all of the media reports you hear about global warming and the greenhouse effect, you may think the greenhouse effect is a phenomenon caused only by humans' actions, an unnatural event. Although it is true that humans seem to be contributing to global warming, it's important to remember that the Earth's atmosphere acts as a very natural and life-sustaining greenhouse – and it has for millions of years. Did you know that without the natural greenhouse effect, scientists estimate that the world would be 30 degrees Celsius cooler than it is now?

The Earth's climate is driven by a continuous flow of energy from the sun. This energy arrives mainly in the form of visible light. The sunlight that reaches the Earth warms both the atmosphere and the Earth's surface. About 30% of this energy is scattered immediately back into space but most of the remaining 70% passes through the atmosphere to warm the Earth's surface. The Earth must send this energy back into space in the form of infrared radiation (heat). Greenhouse gases in the Earth's atmosphere (water vapour, carbon dioxide, methane, and CFCs) warm the atmosphere because they absorb and re-emit heat. In other words, they block infrared radiation from escaping directly from the Earth's surface to space. All greenhouse gases except CFCs occur naturally in the atmosphere. Did you know that the majority of the natural warming is due to water and vapour – about 97%?

The way greenhouse gases trap or warm is somewhat like a greenhouse. This is why many scientists refer to this process as the Greenhouse Effect. In reality, the dominant process responsible for heating air in a greenhouse is quite different from that which heats the lower atmosphere. In a greenhouse, the cooling of the air by circulation is restricted because of the glass enclosure. Despite this difference, the greenhouse effect has become the popular term to refer to both natural AND unnatural (enhanced) atmospheric warming.

Key Words

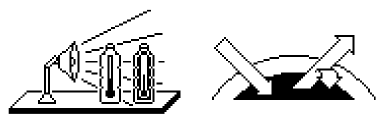
Greenhouse Effect, Greenhouse Gases, Natural Greenhouse Effect, Enhanced Greenhouse Effect

Sources

Environmental Science, Earth as a Living Planet Daniel B, Botkin John Wiley and Sons Inc. New York, 1998

Earth Sciences : Lesson #7

How is the Earth Like a Greenhouse?



OBJECTIVES:

Students will be able to

- work as a cooperative group to complete a task
- make predictions, observations, and explanations about an experiment involving continual data measurements
- make their own comparisons of their experiment to the Earth's warming system
- define the "greenhouse effect" and some of the common misconceptions

MATERIALS:

Class set of Experiment Activity Sheets and 6 of each of the following: lamps, 500ml empty capped plastic bottles (pre-cut approx. 2 inches from top), thermometers, cups of water, mounds of play dough, recorder sheets, meter strips of masking tape, and white, dark blue, and preconstructed multiple coloured construction paper 15cm x 10cm (instructions given in Introduction)

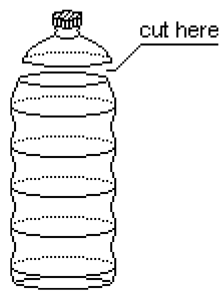
PROCEDURE:

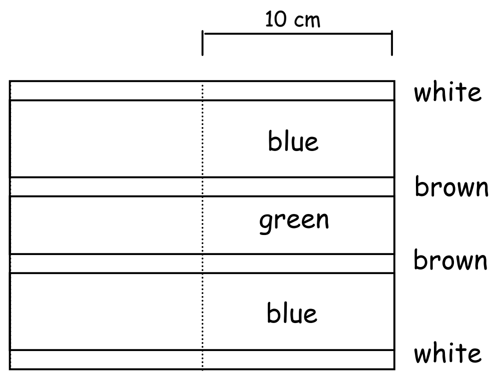
INTRODUCTION

This set of experiments begins with very little instruction as to what the final purpose of it is. By using a Predict, Observe, and Explain (POE) format, the students should try and make connections and draw conclusions themselves.

Cut the tops off the bottles before the beginning of the lesson so that the students can easily place the cardboard and thermometers inside later.

The coloured cardboard pieces should also be cut into strips with the following widths: white 1 cm, blue 4 cm , brown 1 cm, green 3 cm, brown 1 cm, blue 4 cm, and white 1 cm. Attach the long strips of coloured pieces as shown below and then cut at 10 cm intervals to make 15 cm x 10 cm rectangles.





MAIN ACTIVITY:

Divide the class into groups of 4 and assign an individual from each group to the following tasks.

Materials Manager: collects the materials needed for the experiment and returns them at the conclusion of the lesson.
Official Timer: keeps track of the time, signaling the Temperature Reader when to read the temperature.
Temperature Reader: watches the temperature changes during the experiment and reads the temperature out loud when signaled by the Official Timer.
Data Recorder: records the temperature read by the Temperature Reader, on the recorder sheet.

Have the Materials Managers gather the following material for their group. Once they are back to their desks, have them check off the squares on the top of their recorder sheet for all the materials they have.

(WARNING: Thermometers may break causing the danger of both mercury poisoning and cuts from broken glass. Warn students to be extra careful with them and not to go near them if any break.)

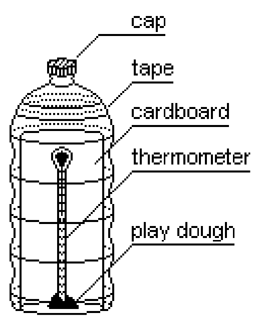
- 1 mound of play dough
- 1 plastic bottle
- 1 m of tape
- 1 recorder sheet
- 4 hand-out sheets
- 1 lamp
- 1 thermometer
- 1 cup of water
- construction paper (1 white, 1 black, 1 multicoloured sheet)

The students should take turns setting up the apparatus for the four stages.

STAGE 1: WHITE PAPER

Before the apparatus is set up, the students should fill in the Stage 1 Prediction square on their Experiment Activity Sheet. Ask them to describe what will happen to the temperature of the thermometer in the bottle.

Describe the role of each student to them and tell them that they should begin as soon as the bottle is sealed shut with the tape. The first student assigned to set up should use the diagram found on the Experiment Activity Sheet to see how the apparatus is to be assembled. They then begin by turning the lamp on and facing it toward the bottle, approximately 15 cm away.



The **Official Timer** continues to mark 1-minute intervals for the **Temperature Reader** to read the temperature until the **Data Recorder** records 3 unchanged temperatures in a row. At this point the final temperature is recorded in the "Final" box.

Upon completion of the data collection, the student who set up the apparatus should remove the tape, remove the thermometer, and turn off the lamp. All four students then copy the final temperature into the Stage 1 Observation square on their POE form along with a description of what happened. They then discuss a possible explanation as to why the temperature increased, and why it stopped at that temperature. They write this conclusion in the Stage 1 Explanation square on their POE form.

Have each group explain their conclusion to the class. Point out that the temperature inside the bottle was increasing because heat energy from the lamp that was not reflected away, was being trapped within the bottle. The bottle was absorbing more heat then it was giving out. The reason the temperature reached a set level was because the amount of energy leaving the bottle eventually equaled the amount of energy going into the bottle. If the amount that escapes equals the amount that arrives, then nothing changes.

Stage 2: Black Paper

The previous procedure is repeated with a black piece of construction paper instead of white. The students are to write out their prediction as to how this will change the resulting temperature. When the procedure is finished, the explanation should try and explain how the black paper affected the results.

Within the class discussion about why the temperature changed, discuss the absorption of light by the black paper. The black paper absorbed more light then the white paper, which reflected a lot of the light, and therefore there was more heat energy absorbed by the bottle. This would result in a higher end temperature because it would take longer for the escaping energy to equal the incoming energy.

Stage 3: Wet Black Paper

The procedure is repeated again but the black piece of construction paper is dipped in water first. The students are to write out their prediction as to how this will change the resulting temperature. When the procedure is finished, the students should try and explain how the water affected the results.

During the class' sharing of explanations, discuss the actual effect of the water in the bottle. Point out that the heat from the lamp would cause an increase in water vapor throughout the bottle because of the presence of water on the cardboard. Moisture in the air absorbs some of the heat energy that is trying to escape the bottle. As a result, the moisture gives off some of that heat back in the direction of the cardboard and is absorbed again by the cardboard. This increase in absorption increases the temperature that the bottle will reach before everything equals out.

Stage 4: Wet Colour Paper

Have the last student set up the experiment using the coloured paper dipped in water instead of the wet black paper. The students' predictions, observations, and explanations should be concerning how the final temperature of the wet coloured paper compares to the wet black paper.

Take guesses from the class as to why the colour choices, and the amount of each, were used. Have the class fill in the final section of the POE form by trying to explain how the last experiment is similar to our planet Earth. Introduce the term Greenhouse Gas by telling them that moisture in the air is the most common Greenhouse Gas, while carbon dioxide is the second.

CONCLUSION:

An important thing to make sure the class realizes is that the Earth does not work exactly like a true greenhouse, which is caused by the glass and lack of natural air circulation, but it does have the same effect. In this experiment, the plastic of the bottle is not a greenhouse gas but the water moisture in it is. It is the increase in temperature between the black construction paper and the wet black construction paper that truly represents the natural Greenhouse Effect, not simply the temperature difference between the inside or outside of the bottle.

The difference between the temperature of the black and white construction paper represents the “Albedo Effect”. Albedo is the percentage of incoming sunlight that is reflected back. White reflects more light and so would have a higher Albedo than black and therefore would absorb less. This would result in a lower temperature for the white paper. In respect to the earth, this represents an interesting situation. If the temperature increases because of Greenhouse Gases, it can cause melting of the polar ice caps and less world snowfall. The world’s average Albedo would change. This would result in an even further temperature increase because less sunlight would be reflected, leaving more to be absorbed.

The final experiment with the colour paper is most representative of the Earth. It is neither all white nor black and is surrounded by the most common Greenhouse Gas known as water moisture. The colours were chosen to approximately represent the percentages of Earth’s surface that is covered in snow and ice (10% white), oceans and lakes (55% blue), and land and vegetation (35% brown and green).

Each different region on the planet Earth has a different percentage of reflected light. For example, a region like Nunavut would have a high reflection of sunlight during the winter months because of the snow (white construction paper), and the Sahara Desert would reflect a little less because of the sand (light brown construction paper). The Hawaii islands would absorb the most sunlight while reflecting the least because of being surrounded by the ocean (dark blue construction paper).

Additional Activities

Science:

- Students could continue the investigation by coming up with an experiment that is a closer demonstration to the Earth's system. The bottle containing the wet coloured paper could also be filled with the Greenhouse Gas carbon dioxide (use method from lesson #6 – "Shedding Light on Carbon Dioxide"). Students could compare the results.

Language Arts:

- Students could write a fictitious short story about living in a world that is contained in a bottle.

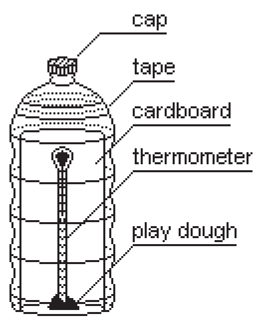
Geography:

- Students could associate different colours and shades to different regions and countries around the world by researching the percentage of area covered in water, trees, and open land.

Experiment Activity Sheet

Name : ______________________________

Date : _____________



Assigned Job

- O Data Recorder
- O Temp. Reader
- O Official Timer
- O Materials Manager

Stage 1: White Paper

Prediction	Observation	Explanation

Stage 2: Black Paper

Prediction	Observation	Explanation

Stage 3: Wet Black Paper

Prediction	Observation	Explanation

Stage 4: Wet Colour Paper

Prediction	Observation	Explanation

How can these experiments be compared to the Earth?

Experiment Recorder Sheet

Names: ____________ ____________
____________ ____________

Materials List

- ○ recorder sheet
- ○ water bottle
- ○ 1 m of tape
- ○ lamp
- ○ play dough
- ○ thermometer
- ○ cup of water
- ○ 4 hand-out sheets

construction paper
- ○ - white
- ○ - black
- ○ - combined colours

Stage 1: White Paper

1	2	3	4	5	6	7	8	9	10	11	12	Final Temperature

Minute Interval

Stage 2: Black Paper

1	2	3	4	5	6	7	8	9	10	11	12	Final Temperature

Minute Interval

Stage 3: Wet Black Paper

1	2	3	4	5	6	7	8	9	10	11	12	Final Temperature

Minute Interval

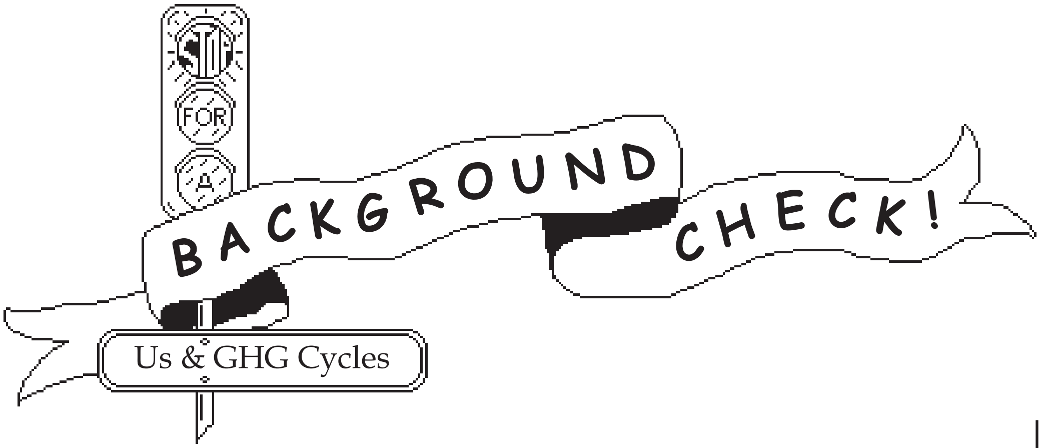
Stage 4: Wet Colour Paper

1	2	3	4	5	6	7	8	9	10	11	12	Final Temperature

Minute Interval

Summary of Collected Data

White	Black	Wet Black	Wet Coloured



The Hydrologic (Water) Cycle

Water continuously circulates from the ocean to the atmosphere to the land and back to the ocean, providing the earth with a renewable supply of purified water on land. This complex cycle is called the water cycle. Water moves from the atmosphere to the land and ocean in the form of precipitation. When water evaporates it forms clouds. Clouds are composed of water droplets. Plants transpire, or give up, about 97 percent of the water absorbed from the soil to the atmosphere.

Water may evaporate from land or flow in rivers and streams to the ocean. This movement is called run-off. Water also seeps downward into the soil. This is called groundwater. Tremendous quantities of water are cycled annually. Some scientists estimate that 389,500 cubic kilometers of water enter the atmosphere each year.

The water cycle plays a major, complex role in determining climatic processes. Evaporation accounts for 50 percent of all surface cooling. Water vapour in the atmosphere is a powerful greenhouse gas. Clouds reflect incoming solar radiation, reducing the sun's input of energy into the environment. Yet, they also trap part of the energy that the sun emits. The water cycle is very complex and is not completely understood.

The Carbon Cycle

Proteins, carbohydrates, and other molecules essential to life contain carbon (C). The global movement of carbon between the abiotic environment and organisms is called the carbon cycle. During photosynthesis, plants, algae and some bacteria remove carbon dioxide (CO_2) from the air and they fix it into sugars. Remember that the equation for glucose is $C_6H_{12}O_6$. Plants use sugars as fuel for cell respiration. This fuel can be used by the plant itself, by a consumer of the plant, or by a decomposer that breaks down the plant. Carbon dioxide is therefore returned to the atmosphere through cell respiration, which breaks down sugars into carbon dioxide and water.

Sometimes, carbon in biological molecules is not returned to the atmosphere for a long time. For example, millions of years ago, coal beds formed from the bodies of ancient vigitation that did not fully decay before they were buried. In the same way, the oils of marine organisms probably gave rise to the world's deposits of oil and natural gas. Coal, oil, and gas are called fossil fuels because they formed from the remains of ancient organisms. They are essentially the result of photosynthesis that occurred millions of years ago. The carbon stored in coal, oil, and natural gas is returned to the atmosphere through burning of these fuels.

Water Cycle, Carbon Cycle, Fossil Fuels, Respiration, Greenhouse Gases

A larger amount of carbon, which leaves the carbon cycle for millions of years, is incorporated into the shells of marine organisms. When these organisms die, their shells sink to the ocean floor and are covered by sediments. These cement together and eventually form limestone. Eventually this sedimentary rock may lift to form land surfaces. As limestone erodes it returns carbon to the water and atmosphere once again.

How Human Activities Produce Carbon Dioxide

Many important human activities emit greenhouse gases (GHGs). Emissions started to rise dramatically in the 1700s due to the Industrial Revolution and changes in land use. Many greenhouse-gas-emitting activities are now seen as essential to the global economy and are an established part of modern life. Carbon dioxide from the burning of fossil fuels is the largest single source of greenhouse gas emissions from human activities. The supply and use of fossil fuels accounts for about three quarters of humankind's carbon dioxide (CO) emissions, one-fifth of the methane (CH_4), and a significant quantity of nitrous oxide (N_2O).

Most emissions associated with energy use result when fossil fuels are burned. Oil, natural gas, and coal furnish most of the energy used to produce electricity, run automobiles, heat houses, and power factories. Extracting, processing, transporting, and distributing fossil fuels also release greenhouse gases. These releases can be deliberate, as when natural gas is flared or vented from oil wells, emitting mostly carbon dioxide and methane, respectively. They can also result from accidents, poor maintenance, and small leaks in well heads, pipe fittings, and pipelines.

It is strongly believed that the abundance of atmospheric CO_2 is much higher today that at anytime in the last 650 thousand years. The previous largest increase in CO_2 levels was 30 ppm over a 1000 yr timeframe, yet they rose by this same amount (30 ppm) just in the 17 years between 1990 and 2007. More than 75% of the increase in atmospheric CO¬2 since pre-industrial times has been caused by emissions from fossil fuel combustion and cement manufacture. Like the CO_2 emitted from fossil fuels, the carbon dioxide released during cement production is derived from limestone and is thus of fossil origin, primarily sea shells and other biomass buried in ancient ocean sediments. Deforestation is the second largest source of carbon dioxide. When forests are cleared for agriculture or development, most of the carbon in the burned or decomposing trees escapes to the atmosphere. However, when new forests are planted the growing trees absorb carbon dioxide, removing it from the atmosphere.

Source

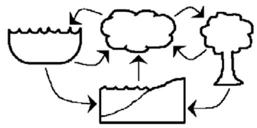
UNFCCC Climate Change Information Kit

A Matter of Degrees: A Primer on Climate Change, Environment Canada, 1997

Environment, Second Edition, Berg et al., 1998

Earth Sciences : Lesson #8

The Carbon Cycle: How to Get Around Like a Carbon Atom



OBJECTIVES:

Students will be able to

- describe the carbon cycle and the Greenhouse Effect
- explain how people are affecting the carbon cycle
- identify predicted results of Global Warming
- speak of methods of action to help reduce the Enhanced Greenhouse Effect

MATERIALS:

character tags (Industry, Home, School, Climate Change, and at least 22 Carbon Atoms), station signs (Oceans and Lakes, Atmosphere, Plants, and Fossil Fuels), over heads (The Carbon Cycle, The Greenhouse Effect, and Carbon Stations), cutout stored carbon signs (1, 100, 1000, and 10000), blank chart for Stage 2, over head markers, rope, tape, and string

PROCEDURE:

INTRODUCTION:

This lesson plan is divided over four days. This is suggested because there is a lot of information to be taken in by the students. There is an introduction section and four cycles. The purpose of these activities is to connect the Greenhouse Effect to Climate Change and show how we are affecting both.

The concepts in these lessons have been extremely simplified. This is done in order to include different aspects of Climate Change and the carbon cycle without making the content too difficult to comprehend. It was also important to select values that would work in the classroom and that would maintain the concept of a cycle. If exact ratios were used, some important transfers would only be represented in decimal format and therefore too difficult to represent with individual students.

(Day 1)

Water Cycle:

Start off by talking about the water cycle. Ask the students to describe what they know about the water cycle. Make sure to bring evaporation into the discussion and the concept of a cycle being a continuous flow of activity that repeats over and over.

Ask the students to describe what water molecules are made of. Explain that it is made up of smaller things called atoms. There are only about 90 different types of atoms that occur naturally and water is made up of the two named Hydrogen and Oxygen. Remind them that we breathe in oxygen. Ask them what type of atom, other than oxygen, we breathe out. If they say Carbon Dioxide, point out that the name of the atom is just "carbon" and that the other word represents the two oxygen atoms to which it is connected.

Carbon Cycle:

Tell the class that there is a carbon cycle in nature, just like there is a water cycle. See how many different ways they can think of that carbon gets around in the world by asking the following questions to help guide them if they have any difficulty. Use the words "*sinks*" and "*sources*" to describe whether the carbon is being taken from the atmosphere (sinks) or helped to be put back into it (source).

- How do living things, like us, put carbon into the air?
    - *Introduce the term respiration for breathing*
    - *Cows make a significant contribution of methane (CH_4) through flatulence*
- If we take in oxygen and put out carbon, what takes carbon in and puts out oxygen?
    - *Introduce the term photosynthesis and point out that plants sometimes also breath out a little carbon through respiration*
- How could carbon get from plants to us?
- What happens if we burn trees or coal?
    - *Introduce the term fossil fuels*

Show the overhead of the carbon cycle and point out different possible ways that the carbon can get around and end up back in the atmosphere. Have the students help suggest different routes.

(Day 2)

Greenhouse Effect:

Ask the class if anyone can guess why it is good to have some carbon dioxide in the atmosphere. Point out that carbon dioxide and some other gasses in the atmosphere have a special effect and are called greenhouse gasses. They get this name because they warm us like a real greenhouse that keeps the plants growing inside it warm.

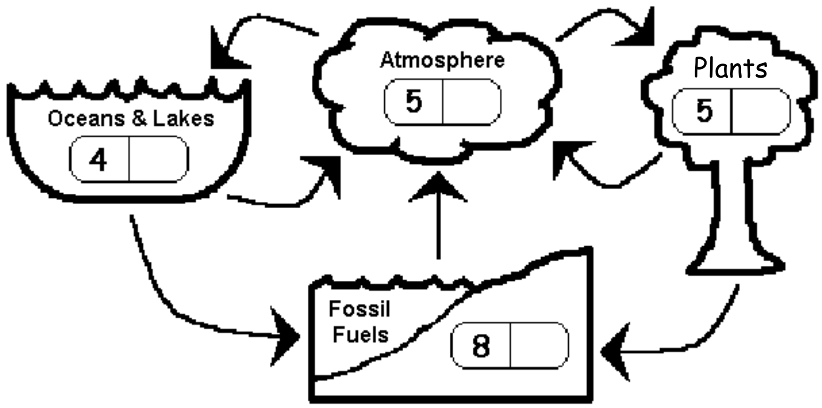
Show the overhead of the Greenhouse Effect and show how (1) the sun sends energy to heat us up, (2) a lot of it is lost into space, but (3) the greenhouse gasses catch the heat energy and send some of it back to warm us up a little more. If it weren't for the greenhouse gasses, we would be 30 degrees Celsius colder than what we are now. Have the class make some predictions on how the world would exist if that were the case.

Main:

Stage 1: The Perfect Cycle:

Divide 22 students into the following groups and give them all "Carbon atom" tags. Have 5 standing at the front by a sign labeled "Atmosphere". Have 4 sitting on one side in a roped off area marked "Oceans and Lakes", and have 5 sitting on the other side with a roped off area marked "Plants". Behind the "Plants" and the "Oceans and Lakes", have 8 students sitting in a roped off area by a sign marked "Fossil Fuels". Have a chart or overhead depicting the four stations and how many students are in each. If there are not enough students to fill the stations, have students wear two tags to represent two atoms. If it is their turn to move to another station yet only one atom is supposed to move, have them leave one of their tags with a student that is not moving from that original station. If there are any extra students at the start of the activity, they can each be given a "Carbon atom" tag and divided among the stations.

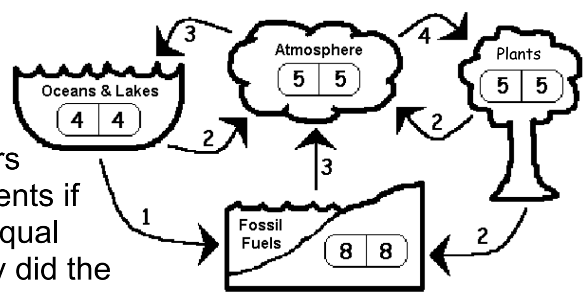
Inform students that these are not exact numbers and therefore they do not truly reflect how many carbon atoms do exist within each section of the world. Remind the class how ratios work. For example, even though there may be three boys to every four girls in the class, it does not mean that there are only three boys and four girls. Ask the class which station they believe has the least amount of carbon in it. Then place the "1 Carbon Atom" sign at the atmosphere station (It is the lowest because of lack of density). Then take guesses as to where to place the other signs (100 – Plants, 1000 – Oceans and Lakes, and 10000 – Fossil Fuels). Remind them that these represent approximate ratios, not exact numbers or counts. They are introduced into the lesson so that a station never appears to be entirely void of carbon atoms. When doing your final count at the end of each cycle, leave out these extra carbon atoms.



Use the formula on the attached sheet "Cycle 1: The Perfect Cycle", to complete the cycle. Ask the students the lead question first to review what was previously discussed and then adapt their answers to signify the desired instruction in the formula below. While the atmosphere is affecting or being affected by either the "Plants" or "Oceans and Lakes", have the students who represent the atmosphere stand around the appropriate group. When they are done, the atmosphere carbons that are remaining return to the starting point at the front of the class. Have the students that are going to the "Fossil Fuel" location crawl there in order to represent the long amount of time it takes to form the "Fossil Fuel". If any are sent into the atmosphere they may simply stand and walk to the front.

Have the students organized in each station so that you can recognize whose turn it is to move. It should follow the "First in - First out" method where the student that has been there the longest gets to move next. This could involve a simple line or a circle with a set front point.

TIE UP 1ST CYCLE:



Return to the original chart and write the new total of students for each station beside the old total. The numbers should not have changed. Ask the students if they can explain why the numbers are equal and to predict what would happen if they did the cycle again. Is it a perfect cycle?

PREPARATION FOR NEXT STAGE:

Discuss with the students how they could improve the cycle to be more relative to the present world? For homework, have the class come up with their own predictions on how people can effect the three stations (Oceans & Lakes, Plants, and Fossil Fuels).

(Day 3)

Stage 2: The Enhanced Greenhouse Effect:

Assign three of the students as helpers for this cycle. Give the tag ”Industry” to one, “Home” to the second, and “School” to the third. Tell them that they will represent how those different groups interact with the carbon cycle. Give their “Carbon tags” to students who only have one that will now represent two atoms.

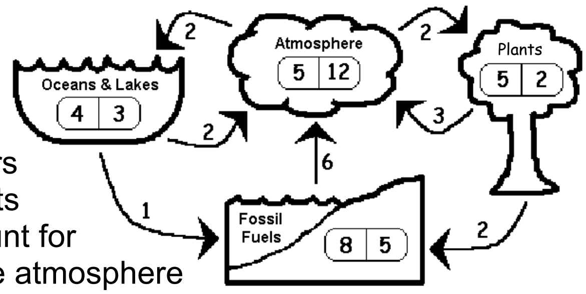
Have the students help brainstorm ways that the three groups affect the oceans and lakes, plants, and fossil fuels. Main issues to look at would be electricity, heating, and transportation. Fill in the following chart with the students’ answers while making sure to include the ones already marked below in the discussion. Review what carbon “sources” and “sinks” are by having the students label the different effects listed on your chart as either affecting carbon “sinks” or “sources”.

	Oceans & Lakes	Plants	Fossil Fuels
Industry	- pollution from shipping *(sink)*	- clear-cutting trees *(sink)*	- wasting heat and electricity - too many trucks *(sources)*
Home	- pollution from recreational boating *(sink)*	- forest fires caused by misuse of campfires *(source and sink)*	- drive everywhere - bad energy use - bad insulation *(sources)*
School		- over use of paper *(sink)*	- heat all week-end and night - leave lights on *(sources)*

Run through the carbon cycle activity again but when “Industry”, “Home”, or “School” are mentioned, have the appropriate labeled student actually take the carbon atom (student) he or she is responsible for to the desired location. In the situation where both “Home” and “Industry” are responsible for only one atom between the two of them, have them both take a different hand from the same student and escort him or her to the correct place.

Start the cycle off the same way as the last time and with the same number of students in each station. Write the starting number for each station on a chart or overhead like before. Use the formula on the attached sheet “Cycle 2: The Enhanced Greenhouse Effect”, to complete the cycle.

TIE UP 2ND CYCLE:



Return to the original chart and write the new total of students for each station beside the old total. The numbers should have changed. Have the students calculate the +/- change of carbon amount for each station. Look at the increase in the atmosphere specifically. Ask the students to try and guess what could happen to the earth if the carbon in the atmosphere greatly increased. Introduce the term "Global Warming" to the class while reviewing what the greenhouse effect is.

PREPARATION FOR NEXT STAGE:

Have students come up with ways that the increase of global temperature could affect the world. Ask them to come up with as many unique ways they can think of.

(Day 4)

Stage 3: Global Warming:

Discuss the concepts that students came up with considering the effects of an increased global temperature. Not all aspects to be mentioned will be negative but make sure that any related negative side effects are connected to it. Below are some main issues to look into and points that should be brought up if the students don't come up with them themselves.

- How would an increase in temperature affect water and the ice caps?
  Increase in water level and melting of ice caps
  - How would that affect coastlines and the carbon cycle?
    More erosion of limestone and submerging of coastlines

- Are lightning storms more common in the winter or the summer?
  Increase in severe weather
  - How could an increase in severe weather affect forests?
    More lightning storms create more forest fires

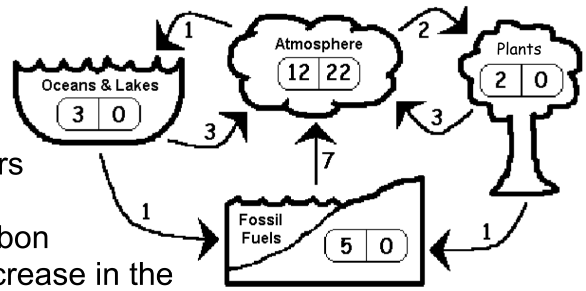
- Can the change of a few degrees in temperature have a great affect on plants and animals?
  Yes, change in appropriate living climates for different plants and animals
  - What would happen if some animals and plants could not survive in their newly changed environment?
    Marine plants and trees die because they do not adapt fast enough or migrate

Begin this cycle with the same number of students in each station that were left at the end of the last cycle (The Enhanced Greenhouse Effect). Write the starting number for each station on a chart or overhead like before. If exactly 22 students were being used as carbon atoms for the activity, there should be the following ratios:

"Atmosphere" = 12
"Oceans and Lakes" = 3
"Plants" = 2
"Fossil Fuels" = 5

Choose another volunteer, or yourself, as the representative of "Climate Change". This new character will affect the carbon cycle in manners that would be the result of global warming caused by the already unbalanced cycle. Have "Climate Change" put on the appropriate tag and join the three previous helpers: "Industry", "Home", and "School". Do the cycle again while reviewing the effects of the previous three characters while demonstrating the new effects of "Climate Change". Use the formula on the attached sheet "Cycle 3: Global Warming", to complete the cycle.

TIE UP 3RD CYCLE:



Return to the original chart and write the new total of students for each station beside the old total. The numbers should have changed again. Have the students calculate the +/- change of carbon amount for each station. Look at the increase in the atmosphere specifically. If you used exactly 22 students, the results would show 0 carbon in all stations except for the atmosphere. Make sure you remind the students that the exercise is just a demonstration of different points and that all the carbon underground and from trees and oceans is not predicted to completely move into the atmosphere.

STAGE 4: TAKING ACTION:

Inform the students that the "Enhanced Greenhouse Effect" is already believed to be taking place because of the increase in atmospheric carbon caused by humans. It is also believed that the process of "Climate Change" has begun, but if people start taking action to cut down the amount of carbon released into the atmosphere, the drastic effects could be reduced. Have the students help you come up with alternatives to the harmful actions by the "Industry", "Home", and "School".

Begin this cycle with the same number of students in each station that were at the beginning of the previous cycle (Global Warming). Write the starting number for each station on a chart or overhead like before. If exactly 22 students were being used for the activity, there should be the following ratios:

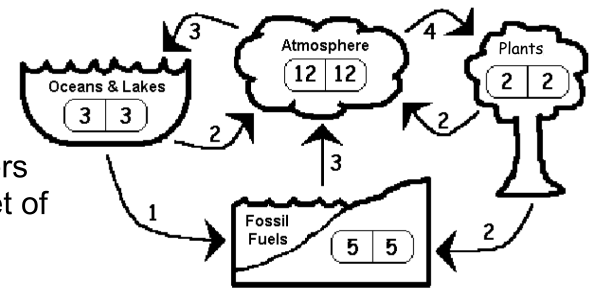
"Atmosphere" = 12
"Oceans and Lakes" = 3
"Plants" = 2
"Fossil Fuels" = 5

Let the students know that the "Climate Change" character will not be used this time but will if the carbon still seems to be increasing in the atmosphere after this run through. Do the cycle again while reviewing the effects of the previous three characters and explaining what new actions are or can be taken. Use the formula on the attached sheet "Cycle 4: Taking Action", to complete the cycle.

Within the cycle is a program called "The Walking School Bus". Parent volunteers follow a preplanned walking path to the doors the students that can not yet walk to school on their own yet are close enough to walk with an escort. Along the route, while following a schedule, the parent volunteers pick up the participating students and walk them as a group to the school Form more information, visit the following web site. http://www.walkingschoolbus.org/Walking_School_Bus_Basics.pdf

TIE UP 4TH CYCLE:

Return to the original chart and write the new total of students for each station beside the old total. The numbers should not have changed from the onset of this cycle.

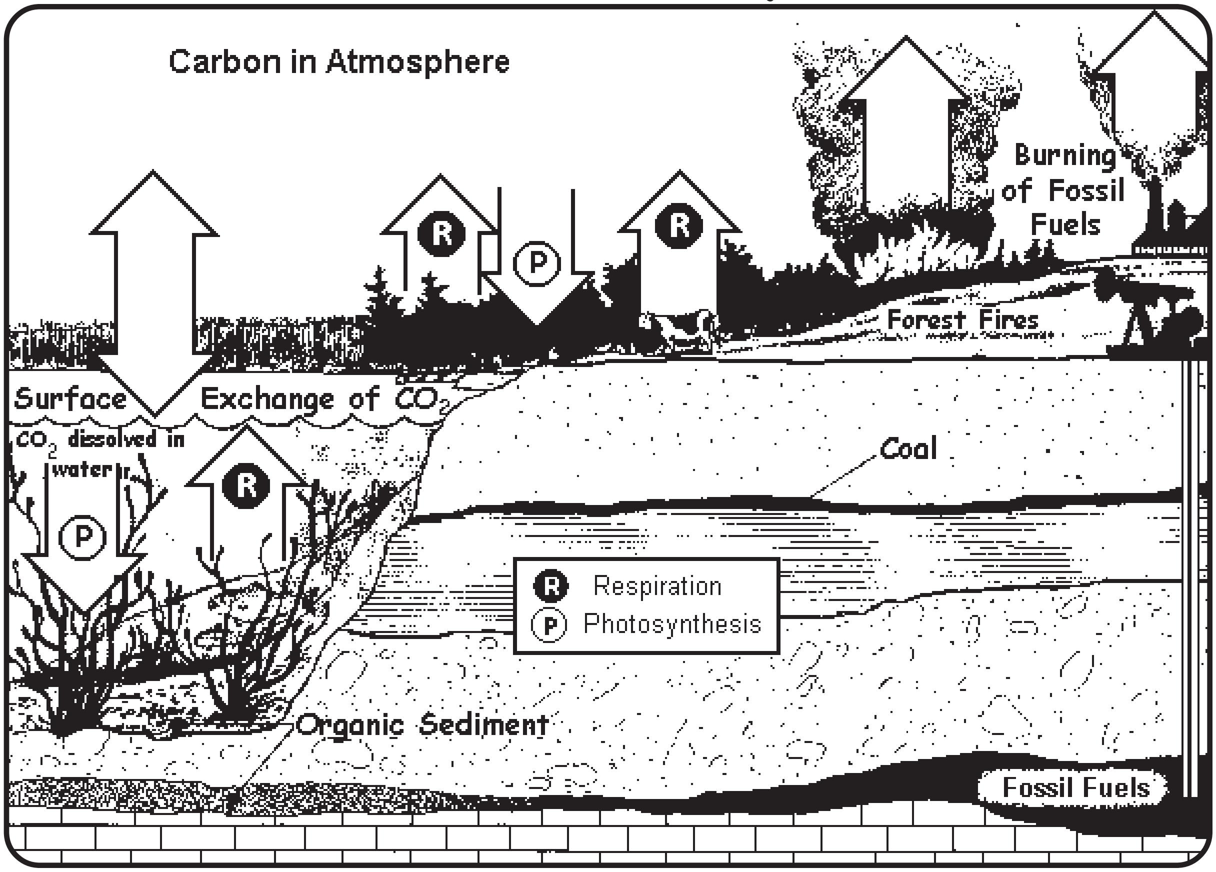


CONCLUSION:

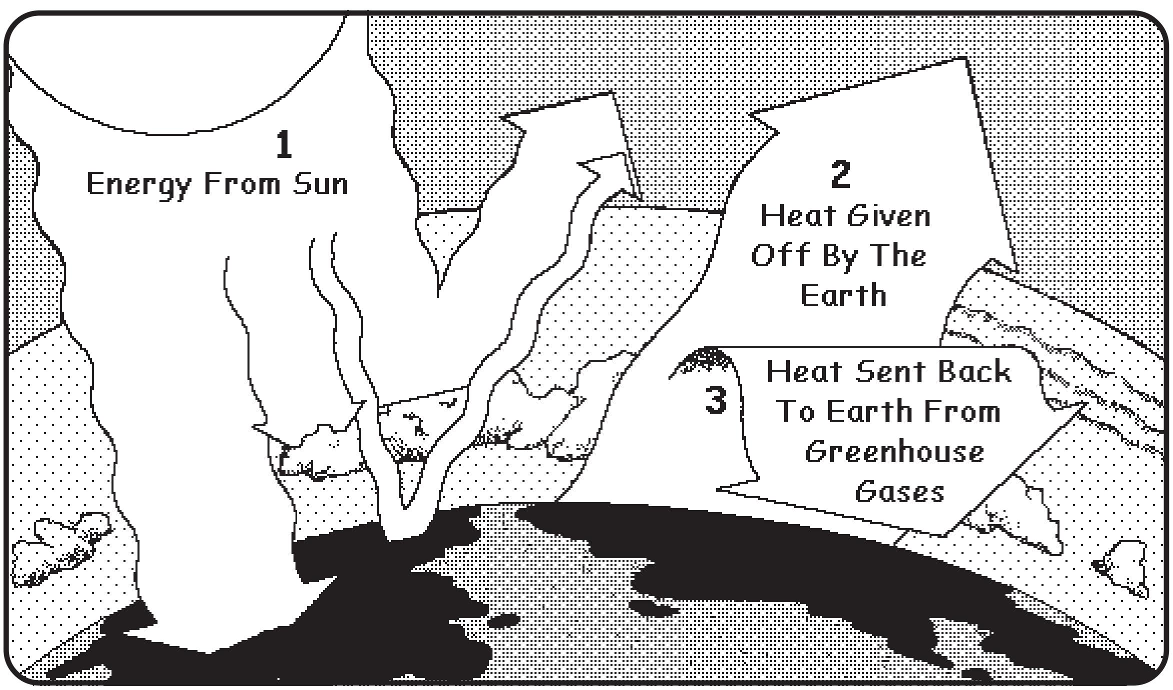
Display the data from the four cycles so that the whole class can see the results. Ask the students to try and answer the following questions.

What is different between the last cycle and the two before it?
What is different between the last cycle and the first one?
If the final cycle were to be repeated over and over, would there be any need for the "Climate Change" character?
Are all of these actions being completely followed by the real factories, our actual schools, and us in our own homes?

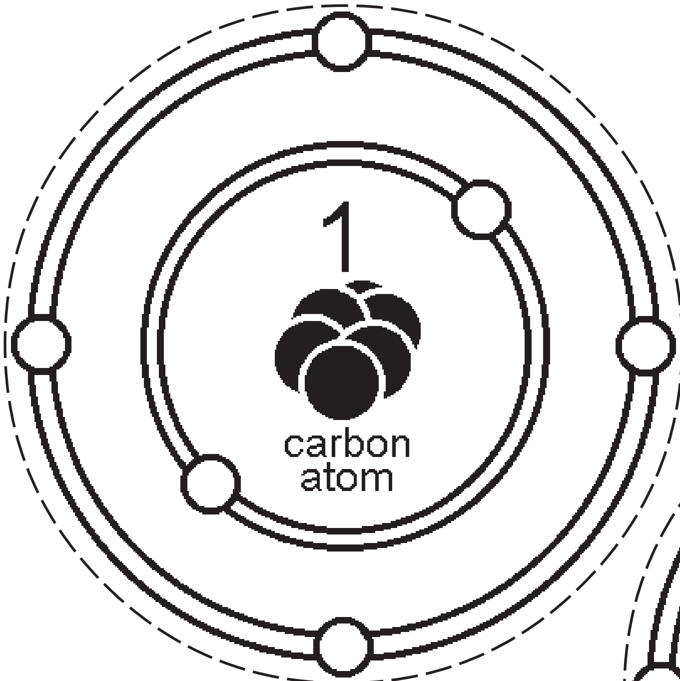
The Carbon Cycle

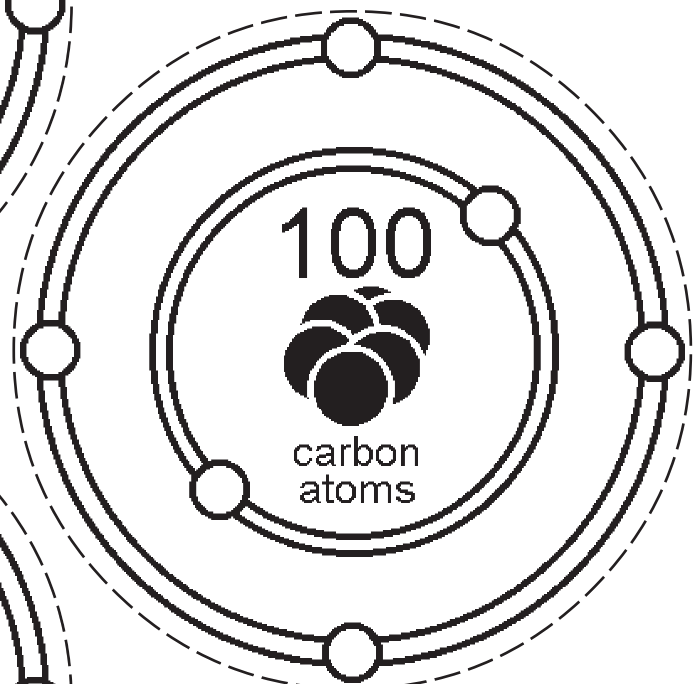


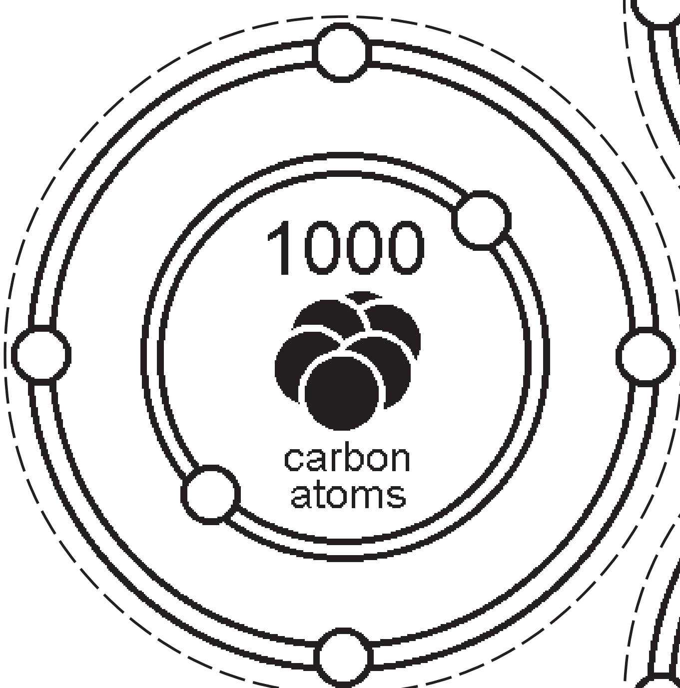
The Greenhouse Effect

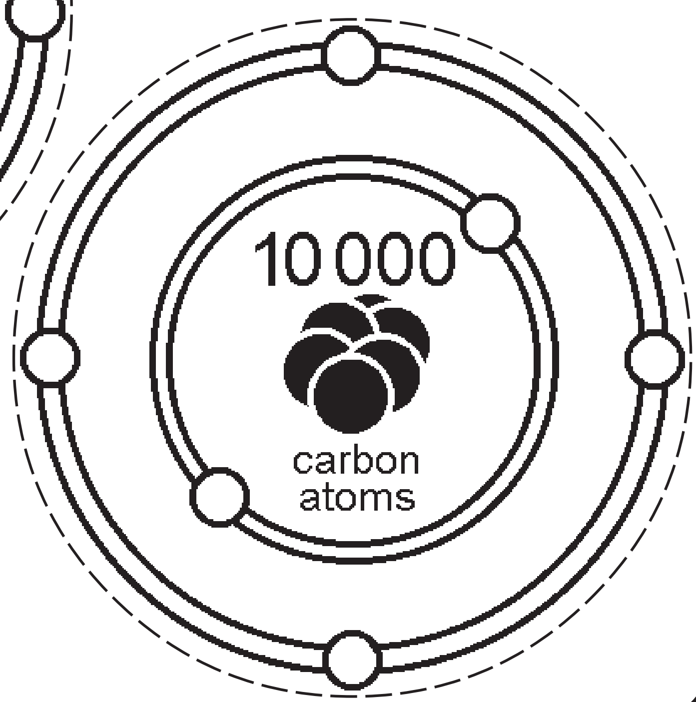


Stored Carbon Signs

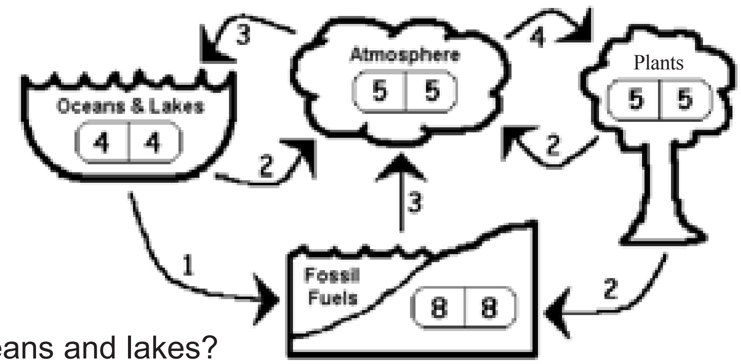








Cycle 1: The Perfect Cycle



Atmosphere ⇔ Oceans and Lakes

How can carbon get into the oceans and lakes?
1 atom dissolves into the ocean. **2** more atoms are taken by marine plants because of photosynthesis. Therefore a total of 3 students join the "Oceans and Lakes" students.

How can carbon, already in the oceans and lakes, get back into the atmosphere?
1 evaporates back into the atmosphere because of the heat from the sun. **1** more is sent back because of respiration by fish and marine plants.

Atmosphere ⇔ Plants

What process allows carbon to be collected by plants?
4 atoms are taken by plants because they need it for photosynthesis.

What natural process can cause forest fires?
2 carbon atoms are sent back into the atmosphere because of forest fires started by lightning strikes.

Plants, Oceans and Lakes ⇔ Fossil Fuels

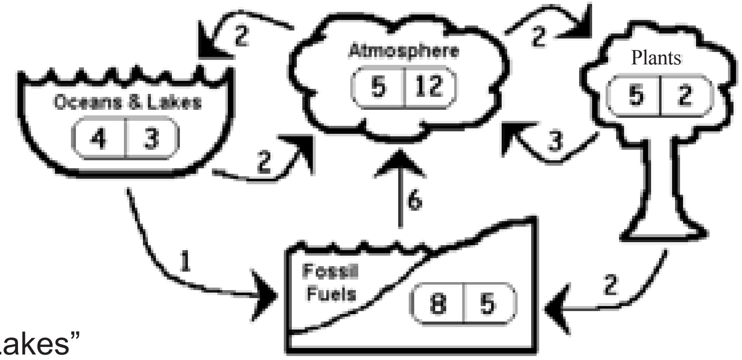
There have been some carbon atoms sitting in the oceans for a long time. What happens to the carbon in the fish and marine plants after they die?
1 carbon atom from the marine life settles at the bottom of the ocean and eventually gets buried and becomes limestone or natural gas which is a fossil fuel.

What happens to some plants that do not decay naturally?
2 carbon atoms, after a long wait, are sent to fossil fuels from buried plants because they turn into coal.

Fossil Fuels ⇒ Atmosphere

Without any help from humans, how can carbon from underground get back into the atmosphere?
3 carbons move back into the atmosphere because of erosion of limestone and the eruption of volcanoes.

Cycle 2: The Enhanced Greenhouse Effect



Atmosphere ⇔ Oceans and Lakes

3 carbon atoms join the "Oceans and Lakes" because of photosynthesis and dissolving.

- (Have them stand within the sitting group labeled "Ocean and Lakes".)

1 is sent back into the atmosphere by **"Industry"** and **"Home"** because they polluted the water and killed off some of the marine life before it could be a carbon sink.

- (The 2 that remain standing in the "Oceans and Lakes" sit down because they actually dissolved or made it through photosynthesis.)

2 are sent back into the atmosphere because of evaporation caused by the sun and the respiration by fish and marine plants.

Atmosphere ⇔ Plants

4 atoms are taken by plants through photosynthesis.

- (Have them stand within the sitting group of "Plants" carbon students.)

2 are sent back into the atmosphere because the trees that would have taken them were cut down by **"Industry"** to produce the paper that the **"Schools"** were wasting.

- (Therefore only 2 actually made it and get to sit down in the group.)

2 carbon atoms are sent back into the atmosphere because of fires from lightning strikes.
1 more is sent into the atmosphere because of careless fires started by **"Home"** while vacationing.

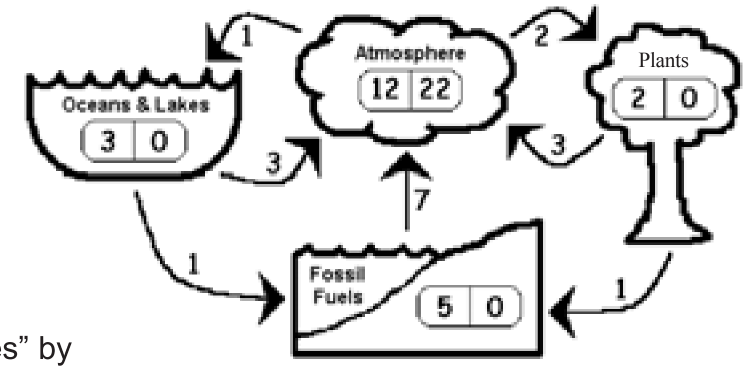
Plants, Oceans and Lakes ⇔ Fossil Fuels

1 carbon atom from the marine life makes it to fossil fuels.
2 carbon atoms from plants also become fossil fuels.

Fossil Fuels ⇒ Atmosphere

3 carbons make it into the atmosphere from natural erosion and volcanoes.
1 carbon atom is also added because of the trucks that **"Industry"** keeps using and also because of its waste of energy and heating.
1 carbon atom is added by **"Home"** because of their bad insulation and electricity use along with the need to drive everywhere.
1 extra atom is added by the **"Schools"** for forgetting to turn lights off and for leaving the heater on all weekend and nights.

Cycle 3: Global Warming



Atmosphere ⇔ Oceans and Lakes

3 carbon atoms join “Oceans and Lakes” by photosynthesis or dissolving. (They remain standing.)
1 carbon atom is sent back by **“Industry”** and **“Home”** because of pollution.
1 more is sent back because the temperature increase due to **“Climate Change”** has killed off some of the marine plant vegetation needed for photosynthesis of carbon.

2 are sent back into the atmosphere because of evaporation caused by the sun and the respiration by fish and marine plants.
1 additional carbon is sent back by **“Climate Change”** because an increase in temperature means an increase in evaporation.

Atmosphere ⇔ Plants

4 atoms are taken by the plants through photosynthesis. (They remain standing.)
2 are kept from sitting with the “Plants” because trees were cut down by **“Industry”** for paper wasted by the **“Schools”**.

2 carbon atoms are sent back into the atmosphere by fires started from lightning strikes.
1 more is sent into the atmosphere because of fires started by the additional lightning storms brought by **“Climate Change”**.

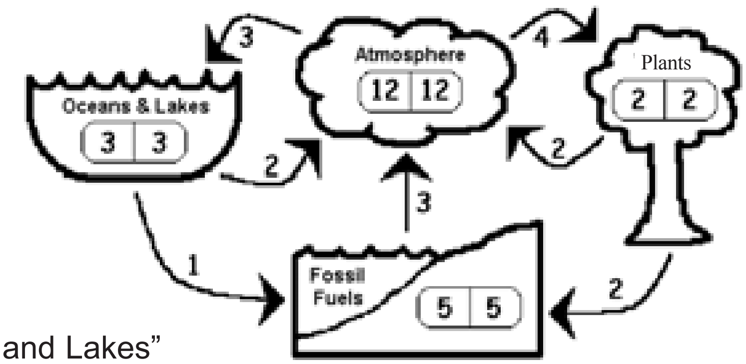
Plants, Oceans and Lakes ⇔ Fossil Fuels

1 carbon atom from the marine life makes it to fossil fuels.
1 carbon atom from plants also becomes fossil fuel.

Fossil Fuels ⇒ Atmosphere

3 carbons make it into the atmosphere from natural erosion and volcanoes.
1 more carbon atom is sent by the energy waist and trucks by **“Industry”**.
1 carbon is added by **“Home”** because of bad insulation, electricity, and car use.
1 more is added by the **“Schools”** for forgetting to turn lights and heating off.
1 last carbon is sent into the atmosphere by the increase in the erosion of limestone by the increase in water level caused by **“Climate Change”**.

Cycle 4: Taking Action



Atmosphere ⇔ Oceans and Lakes

Only 2 carbon atoms join the "Oceans and Lakes" because of pollution affecting photosynthesis and dissolving.
1 more carbon atom is added into the oceans because **"Industry"** is more environmentally conscious with safety precautions and **"Home"** is not polluting protected lakes by recreational boating.

2 are sent back into the atmosphere because of evaporation caused by the sun and the respiration by fish and marine plants.

Atmosphere ⇔ Plants

Only 2 are taken by plants during photosynthesis because of waste and cutting.
2 more are added because **"Industry"** is not cutting protected forests and **"Schools"** are respecting the three R's (Reduce, Reuse, Recycle).

3 carbon atoms are sent back into the atmosphere because of fires started by lightning or camp fires.
1 is sent back to the plants by **"Home"** because of fire safety and respect of the displayed forest fire indexes.

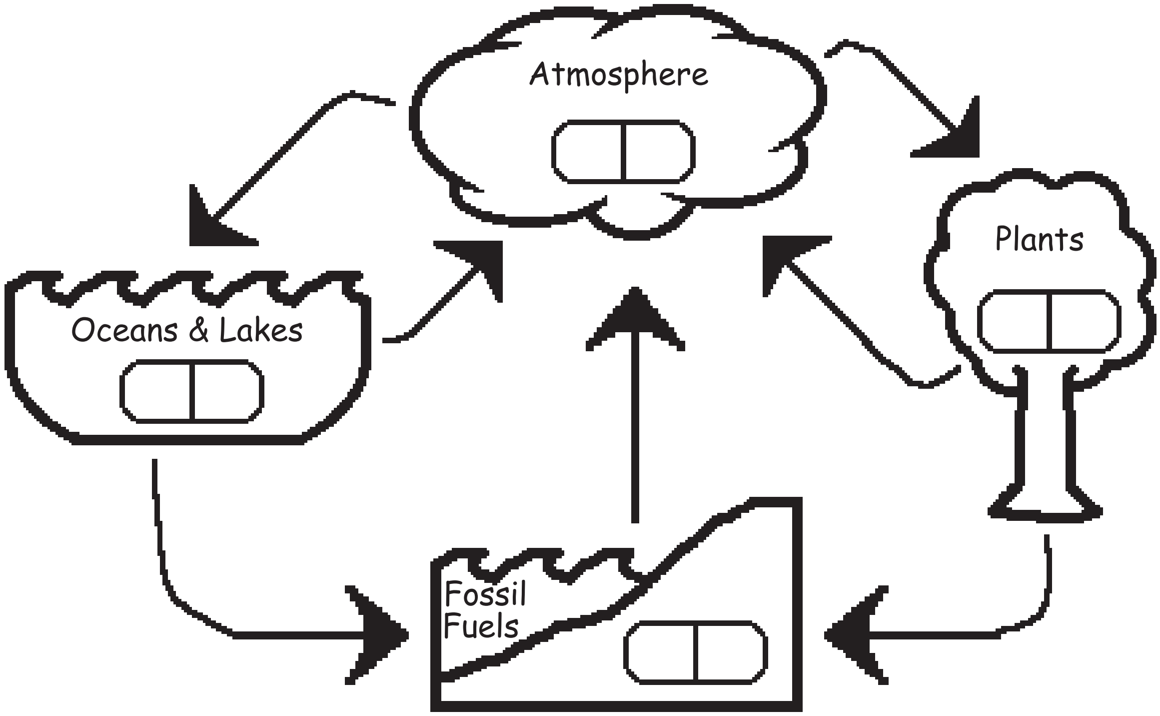
Plants, Oceans and Lakes ⇔ Fossil Fuels

1 carbon atom from the marine life makes it to fossil fuels.
2 carbon atoms from plants also become fossil fuels.

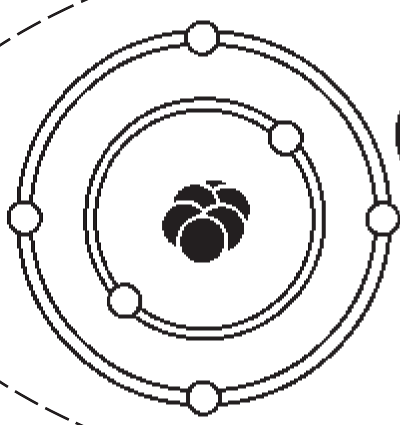
Fossil Fuels ⇒ Atmosphere

6 carbons make it into the atmosphere because of natural erosion, volcanoes, trucks, cars, and energy waste.
1 atom is put back into "Fossil Fuels" because **"Industry"** is using trains and alternative energy sources like wind, sun, and tides.
1 atom is put back by **"Home"** because of better insulation and electricity use. People are also commuting to work to try and cut down on gasoline use.
1 carbon is also put back into "Fossil Fuels" by **"Schools"** because they hooked their lights and thermostats up to timers and have begun doing the "Walking School Bus".

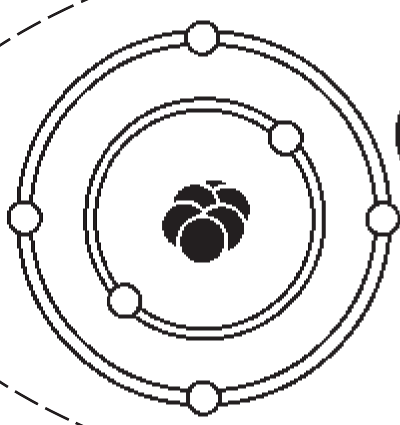
Carbon Stations and Data Chart



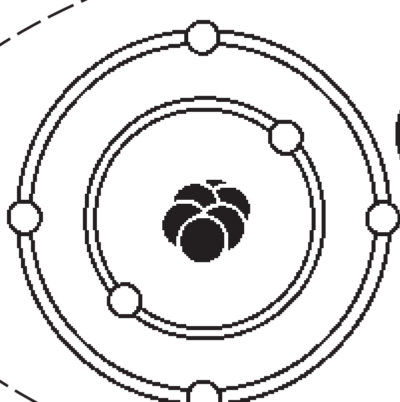
		Oceans & Lakes	Fossil Fuels	Plants	Atmosphere	Atmosphere After - Before =
Cycle #1	Before					
	After					
Cycle #2	Before					
	After					
Cycle #3	Before					
	After					
Cycle #4	Before					
	After					



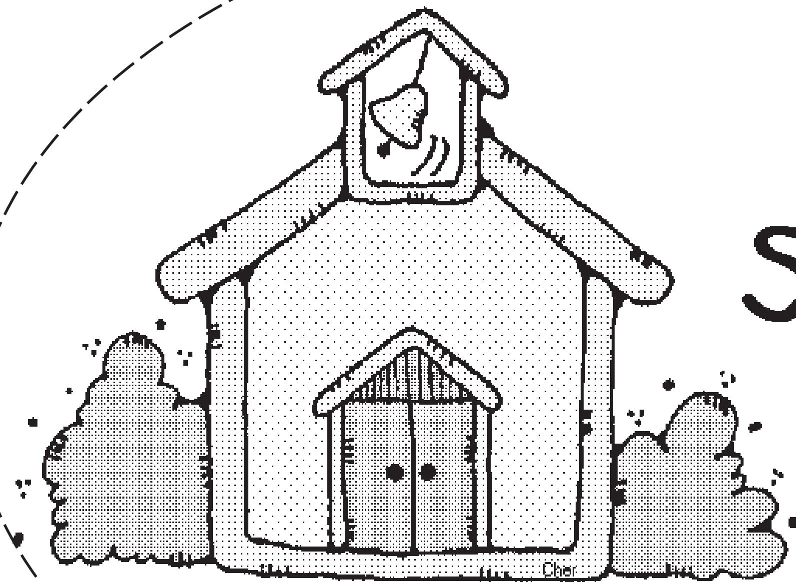
Carbon Atom



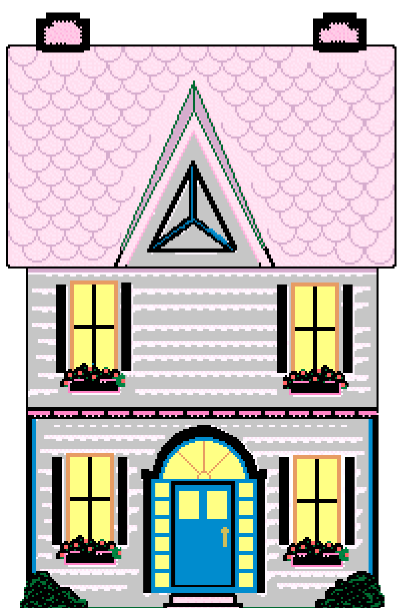
Carbon Atom



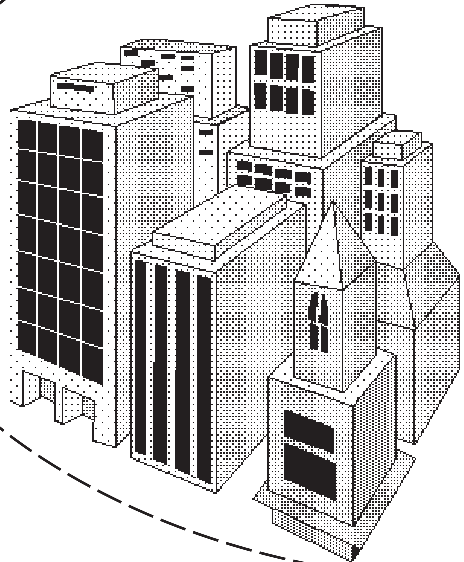
Carbon Atom



School

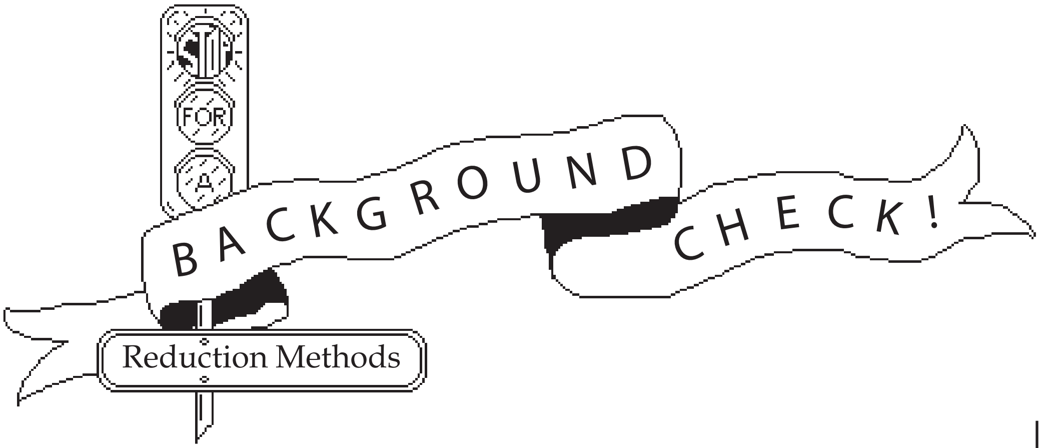


Home



Industry

Climate Change



Personal Emissions

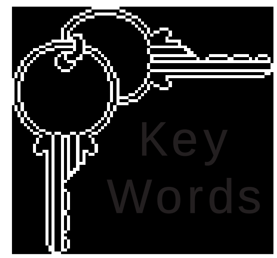
Personal emissions are pollutants that individuals are personally and directly responsible for as a result of their lifestyles and activities at home and on the road. These personal emissions account for about 50% of total Canadian greenhouse gas emissions. The following is a list of some of the personal actions that students can do to reduce emissions.

- Install energy efficient light bulbs
- Turn off lights when not in use
- Compost organic waste materials
- Reduce your use of product packaging where possible
- Doing your laundry in cold water instead of hot
- Reduce the amount of red meat in your diet.
- Buy local produce when you go to the grocery store
- Plant a tree
- Make sure the dishwasher and washing machine are full before running them
- Move your thermostat down two degrees in winter and up two degrees in the summer
- Unplug your cell phone charger and other electronics when not in use
- Take shorter showers
- Look for leaks and drafts in your home and help to seal them
- If you're leaving your computer for a while, put it on stand-by
- Put on warm socks and a sweater before turning the heat on
- Walk or bike rather than driving
- As always, Reduce, Reuse, Recycle!

Recycling

Products made from recycled materials require much less energy to manufacture. For example, die casting a part from recycled aluminum requires 95 % less energy than using primary metal. Saving energy means less carbon dioxide emitted into the atmosphere. Recycling paper products such as newspapers and cardboard saves trees. The average Canadian family uses up to 12 trees every year in paper products. Most of this ends up in garbage dumps and landfill sites. Trees play an important role in regulating the amount of carbon dioxide in the atmosphere. Saving trees helps stop global warming.

The average Canadian generates approximately 385 kg of garbage every year. Nearly half of all solid waste collected in Canada is made up of consumer or household garbage. Reducing the amount of garbage ending up in landfill sites can have a positive effect on the amount of methane that is released into the Atmosphere.



Reductions, Personal, Industry, Government, Regulatory, Economic, Voluntary

Industry

Industries could put more emphasis on manufacturing goods that are more durable and have less packaging.

When construction or modernization projects are planned, changing risks from a warmer climate, such as the frequency and severity of floods and droughts, should be factored into design considerations.

Scientists will have an opportunity to develop new technologies for energy efficiency and alternative energy sources. Research can lead to new agricultural crops, and ways to combat northward-migrating crop and forest pests and diseases. Farmers will have the opportunity to try different crops or crop combinations and cultivation practices.

Foresters can experiment with different species of trees better able to withstand climate change. Opportunities for new industries, technologies, and trading partners can be sought out.

Coastal buildings and other structures such as dikes and bridges can be adjusted to withstand increased storms and flooding due to rises in sea level. Buildings in low-lying areas near large rivers can also be protected or reinforced. Emergency measures for disasters including early warning systems can be implemented in low-lying or problem areas for flooding, cyclones, and drought. The developed countries may need to establish plans to help the developing countries most at risk. Food security systems and new transportation and distribution routes can be developed.

Government

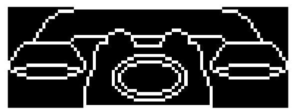
Governments in Canada and in most other countries have essentially three mechanisms to resolve environmental problems:

- regulatory instruments,
- economic instruments, and
- voluntary instruments.

There has been a strong tradition in Canada of using regulatory instruments. This is the "command and control" approach to achieve our environmental goals. The federal government, for example, sets emission standards for automobiles. Regulations set maximum automotive emission levels, on a gram-per-mile basis, for nitrogen oxides, hydrocarbons, and carbon monoxide.

Economic instruments use market forces to integrate economic and environmental decision-making. These instruments can provide the price and other market signals that help decision-makers to recognize the environmental implications of their choices. For example, some economic instruments directly affect the prices facing producers and consumers. Other economic instruments create a market and a price for access to environmental resources.

Governments can encourage the use of alternative energy sources and technology by private citizens and the global community. Volunteer efforts are important. These can include: environmental education, corporate environmental stewardship programs, and the development of community-based programs that contribute to environmental goals.



Sour c e
E
E

Environment Canada, www.ec.gc.ca

Statistics Canada. Human Activity and the Environment: Annual Statistics http://www.statcan.gc.ca/bsolc/olc-cel/olc-cel?catno=16-201-XIE&lang=eng

Environment Canada, Canadian Pollution Prevention Information Clearinghouse http://www.ec.gc.ca/cppic/citizens/En/index.cfm

Earth Sciences : Lesson #9

Objectives:

Students will be able to

- work as a cooperative group to complete a task
- list Greenhouse Gas reduction techniques for various groups of individuals
- rank tasks on the task's ease and effectiveness
- make a compromise between two concepts to decide on a conclusion

Materials:

Class set of handout sheets and scissors, 5 pieces of chart paper, 5 different coloured markers, an old magazine, ballot box

Procedure:

Introduction:

This activity is a common brainstorming technique called a "Carrousel" and is adapted to the topic of Greenhouse Gas reduction. The following is a fun technique used to divide the class into groups while strengthening their communication and problem solving skills.

Put up five different pieces of chart paper around the room with the numbered headings (#1) Government, (#2) Industry, (#3) Home, (#4) School, and (#5) Transportation.

Take five different pages from a magazine. Choose pages so that they can be appointed to group #1, #2, #3, #4, or #5, by the initial digit of the page number (For example pages 13, 24, 38, 42, and 56). Do not use pages that have one initial digit on one side but a different one on the other side (For example, pg. 39/40). Cut each page into the same number of pieces as the number of students that you would like in that group. Try to evenly distribute the students among the groups. The students must find the other people in their group by matching the pieces. Inform them to not lose track of their piece because they will have to know which one is theirs later. Once the groups are organized, they go to the chart paper which has the number matching the initial digit of their magazine page number.

MAIN ACTIVITY:

Distribute a different coloured marker to the recorder for each group. The recorder can simply be chosen as the one who had the front, upper, left corner piece to their group's puzzle. Within a one-minute period, the group must think of as many different ways as possible for their heading (government, school, etc.) to reduce greenhouse gas emissions. While the group says their answers out loud, the recorder writes them on the chart paper, making sure to write close together to ensure room for the other four groups.

When one minute is up, they must move to the next station in a clockwise direction. When everyone is in position and have read over what has already been written by the previous group, have them add their own ideas for that category within another minute interval. They are not to repeat anything that has already been written down on that sheet. This continues until each group has been to each station. The students return to their desks.

Note: The last time interval can be extended to ensure that most possible responses are recorded.

DATA ANALYSIS:

Go to each chart paper and then read the answers aloud to the class, having students clarify any that are ambiguous. Circle five different reduction ideas for each category that appear to cover a wide range of issues. Hand out the activity sheets and have the class rank them in terms of effectiveness, #1 being the most effective at reducing greenhouse gasses. Then have them number the choices in terms of how easy they are to accomplish, #1 being the easiest method of reduction.

The students are to pretend that they are asked to create a Green House Reduction Campaign by advertising different reduction techniques. Ask the students to choose one method of reduction from each of their lists as if they could only advertise one for each category. The chosen reduction method should not be too difficult, resulting in no one wanting to participate in it, and yet it should not be too ineffective, resulting in barely any reduction of gas emissions. Have the students fill out their choices in the boxes provided, cut them out, and put them into a ballot box for each category.

Collect all choices from the students for the Government category and then create a bar graph from each ballot to find out which choice is the winner. When each new choice is drawn, ask for a volunteer from the class who had voted for that choice. The student is to describe why he or she felt that it was a valid choice. Continue this for the other 4 categories.

CONCLUSION:

The lesson can be wrapped up by discussing the possibility of trying some of the suggestions for the School category. A team can be assembled for each suggestion to try and actually carry them out. The students are encouraged to show the sheet to the adults in their homes to try to implement some of the Home and Transportation suggestions.

Some ideas for reducing emissions in the home and on the road:

- Add or replace insulation
- Replace or upgrade windows in your home
- Have an energy evaluation of your home
- Purchase an energy efficient appliance
- Replace or upgrade your furnace
- Repaint your house with latex paint instead of oil
- Buy energy efficient appliances with the "Energy Star" label
- Call your local utility and sign up for renewable energy
- Get a home energy audit, which may reveal simple ways to cut emissions
- Weatherize your home, caulk, and weather-strip your doorways and windows
- Buy only post-consumer recycled paper products, including toilet paper and tissues
- Buy certified wood to support sustainably managed forests
- Purchase an energy efficient vehicle
- Regularly maintain proper tire pressure on your vehicle
- Drive no faster than the posted speed limit
- Avoid vehicle idling unless in traffic

ADDITIONAL ACTIVITIES

MATHEMATICS:

- More graph work can be done by analyzing the acquired data even further. The class could create graphs of the students' choices of most effective or easiest reduction techniques.

LANGUAGE ARTS:

- The students could write the plan and dialogue for an actual commercial for one of the reduction techniques discussed in the lesson.

VISUAL ARTS:

- Advertisement posters could be made for the school to advertise different reduction techniques that can be done by fellow students and teachers.

What On Earth Can Be Done?

Name : ______________________________

Date : ______________

Ranking Sheet

Government	Industry	Home	School	Transportation
Effective? / Easy?	Effective? / Easy?	Effective? / Easy?	Effective? / Easy?	Effective? / Easy?
1 ______ ☐	1 ______ ☐	1 ______ ☐	1 ______ ☐	1 ______ ☐
2 ______ ☐	2 ______ ☐	2 ______ ☐	2 ______ ☐	2 ______ ☐
3 ______ ☐	3 ______ ☐	3 ______ ☐	3 ______ ☐	3 ______ ☐
4 ______ ☐	4 ______ ☐	4 ______ ☐	4 ______ ☐	4 ______ ☐
5 ______ ☐	5 ______ ☐	5 ______ ☐	5 ______ ☐	5 ______ ☐

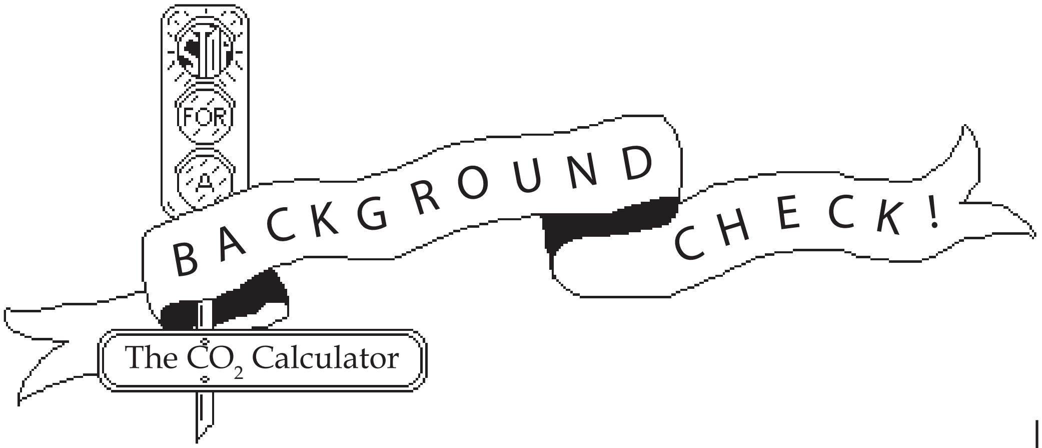
Government

Industry

Home

School

Transportation



The following lesson was created as a link to the already Zerofootprint Kid's Calculator.

This web-based tool can be used to educate Canadians about the use of our resources, and to give them the power to monitor their own contributions. The following description of the project is provided by the creators of the Zerofootprint Calculator.

"The idea behind the calculator is that all of our decisions and patterns of behaviour add up to a "footprint," which is just a way of measuring people's demands on nature. The more we consume, the bigger our footprint is. Indeed, our footprint is global. Much of our food, our goods, our fuel, and our resources come from somewhere else. Plus, our waste, particularly our greenhouse gas emissions, can have an effect on people everywhere.

Our footprint is not confined to Canada. If everyone on the planet consumed resources and goods at the same rate that Canadians do, we would need roughly four planets like ours to provide the basic materials and to absorb our waste. That's just another way of saying that something has got to give.

The calculator provides numbers in terms of carbon dioxide, water, trees, and land. For example, the average Canadian makes a series of decisions every day that creates nearly 9 tonnes of CO2 each year, while using 1,630,000 litres of water, 3.5 trees, and 3.3 hectares of land.

The Zerofootprint Kid's Calculator accounts for: the things we buy and discard, the way we get around, the way we live and the places we live. "

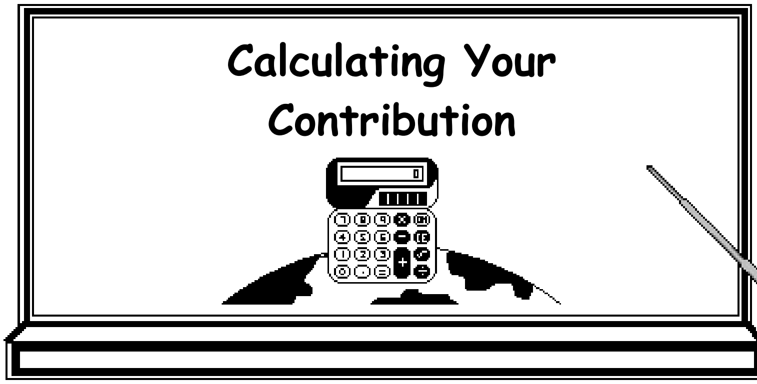
Key Words

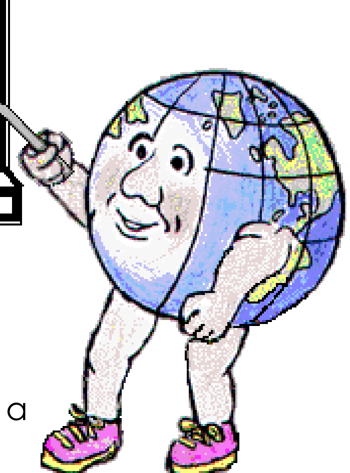
Resource use,
ecological footprint
CO_2 Emissions

Contact

Zerofootprint Calculator
http://www.zerofootprintkids.com/kids_home.aspx

Earth Sciences : Lesson #10





OBJECTIVES:

Students will be able to

- work with an adult in the home to complete a task
- use a new creative writing technique to create a unique story of their own
- help calculate the class' carbon emissions
- suggest ways to reduce their own household's carbon emissions
- make comparisons over time as to how well they, as a group, are helping with the reduction of greenhouse gasses

MATERIALS:

Class set of questionnaires, Internet access (not necessarily within the class), calculator, cut out scale sheets

PROCEDURE:

INTRODUCTION:

This lesson is best initiated during the first half of the school year in order to give a large amount of time for the collection of data. This way a better comparison can be made with the passing of time in order to see if any carbon emission reduction actually occurred. Inform the class that they will answer the question "How do we compare to the average Canadian in CO_2 production and the use of land, trees and water?"

Data Collection:

In this lesson, the students will collect their own data to be inputted into the calculator. Give the activity sheets to the class to be filled out at home. Ask the students to have a parent or guardian at home help them fill out the form for homework. If they have access to a computer at home, ask them to try and have their parent, guardian, or selves enter their own data on the Zerofootprint site. Ask them to bring back a named printout of the result along with the completed questionnaire form. Otherwise the completed form will be sufficient. The students who did not return a printout can either enter the data themselves at school (if there is ample Internet access and time) or you can enter the data at your earliest convenience. The printed responses should have the students' names on them.

STORY WRITING:

Once all the students have returned their forms they can use a copy of their own questionnaire to write a story. They are to write a story that incorporates all the answers that were given on their questionnaire form. It does not matter how they incorporate the words or numbers as long as the overall meaning of the story talks about Greenhouse Gas "Reduction". This is to encourage them to find out ways to reduce the production of carbon dioxide emissions for which their family is responsible, while strengthening their story writing ability. The assessment of the writing would depend on the actual Grade level that the lesson is targeting.

CONCLUSION:

Post the results by assembling two scales for each parameter being measured. Assemble the first scale with the two sides labeled "Our Class on ______" and "Average Canadians". Putthe present date on the "Our Class on ______" label and the number of participants on the scale's base. Label one of the weights with the class' total footprint and attach it to the "Our Class" side. Find out what the Canadian average is from the total results section of the calculator and multiply it by the number of people in your class that supplied data. Label a weight with that final calculation and place it on the "Average Canadian's side. Have the scale tipping towards the side holding the most weight.

Put up the second scale and do the same thing for the "Our Class" side by filling in the present date, attaching the total weight and putting the number of participants on the base of the scale. Leave the other side with only the question marks and have the scale tipped all the way to the weighted side.

If there is a difference between the class's average and the average Canadian, ask them what the reason might be. Discuss with the class if they believe there are any questions that are not useful for this area. Do they feel there are questions that should have been asked, but weren't?

FOLLOW-UP:

Inform the class that the questionnaire will be sent home near the end of the year to be filled out again in order to measure any progress. Send a letter home to the adults within their household thanking them for filling out the questionnaire. Include the printed results and encouragement to try the web-site itself along with the suggested reduction techniques in the printout. Inform them that the class will be repeating the lesson at the end of the year to measure any progress.

When the lesson is repeated, attach the data and weight over the question marks on the scale. If there are fewer students participating this time than there were the first time, calculate the average weight per student from the first time and use that number for as many extra students as you need to equal the same number of participants. If there are more participants this time around, then divide the result by the present number of participants and then multiply that result by the number of participants from the first time.

ADDITIONAL ACTIVITIES

MATHEMATICS:

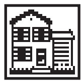
- Look further into the concept of mass. Have the class try and find objects in their surroundings that would approximately equal the same mass as their carbon emission contribution.

Calculator Questionnaire

Name : ______________________________

Date : ____________

HOUSING



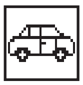
What type of building do you live in?

Detached ☐ Attached ☐ Apartment ☐

How many people live there?

____

VEHICLE



If you have a vehicle at home, what type is it?

Motorcycle ☐ Subcompact/Compact ☐ Midsize ☐

Fullsize/Van/Truck ☐ Snowmobile ☐

What is the vehicle's name?

____

If you have a second vehicle at home, what type is it?

Motorcycle ☐ Subcompact/Compact ☐ Midsize ☐

Fullsize/Van/Truck ☐ Snowmobile ☐

What is that vehicle's name?

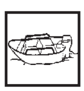
____

WASTE

How many of the following do you generate each week?

bags of waste = _____ boxes of recycling = _____ bags of compost = _____

RECREATION



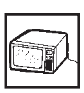
What water vehicles, if any, have your household used in the last year and how many hours for each?

____

How many kilometers, if any, does your household travel in each of the following?

RV = _______ Camper Trailer = _______ ATV = _______

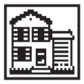
APPLIANCES



Which of the following do you have at home?

Household Lighting ☐	**Window A/C** ☐	**Microwave (# if any ___)** ☐	**Personal Computer (# if any ___)** ☐
Outdoor Security Lighting ☐	**Central A/C** ☐	**Television (# if any ___)** ☐	**Stereo (# if any ___)** ☐
Refrigerator (Age _____) ☐	**Stove (Fuel type _______)** ☐	**VCR (# if any ___)** ☐	**Clothes Dryer (Fuel type if any _______)** ☐
2nd Refrigerator ☐	**Stand Alone Freezer** ☐		

Home Heating



What are your heating fuel types?
primary: _________ secondary: _________

When was your house built?
before 1946 ☐ 1946-1970 ☐ 1970-1990 ☐ 1990-present ☐

How would you rank your primary heating's efficiency, standard { }, middle { }, or high { } ?

If you live in a house, how many square feet is it?
upto 750 ☐ 1000 ☐ 1250 ☐ 1500 ☐ 1750 ☐ 2000 ☐

If an apartment, how many bedrooms? ______

Hot Water

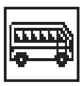
Which of the following heats your water?

Natural Gas ☐ **Electricity** ☐ **Oil** ☐ **Propane** ☐

Check off any of the following that your household has?

Clothes Washer ☐ **Dishwasher** ☐ **Swimming Pool Heater** ☐ **Hot Tub** ☐

Local Travel

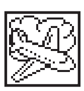


In the squares below, fill out how many weekly round trips your household makes of the listed distances.

Below each one, write the types of transportation you use for that distance and the # of occupancies.

Less than 5 km	5 to 25 km	25 to 75 km	75 to 200 km
☐	☐	☐	☐
_______ , #___	_______ , #___	_______ , #___	_______ , #___
_______ , #___	_______ , #___	_______ , #___	_______ , #___
_______ , #___	_______ , #___	_______ , #___	_______ , #___
_______ , #___	_______ , #___	_______ , #___	_______ , #___

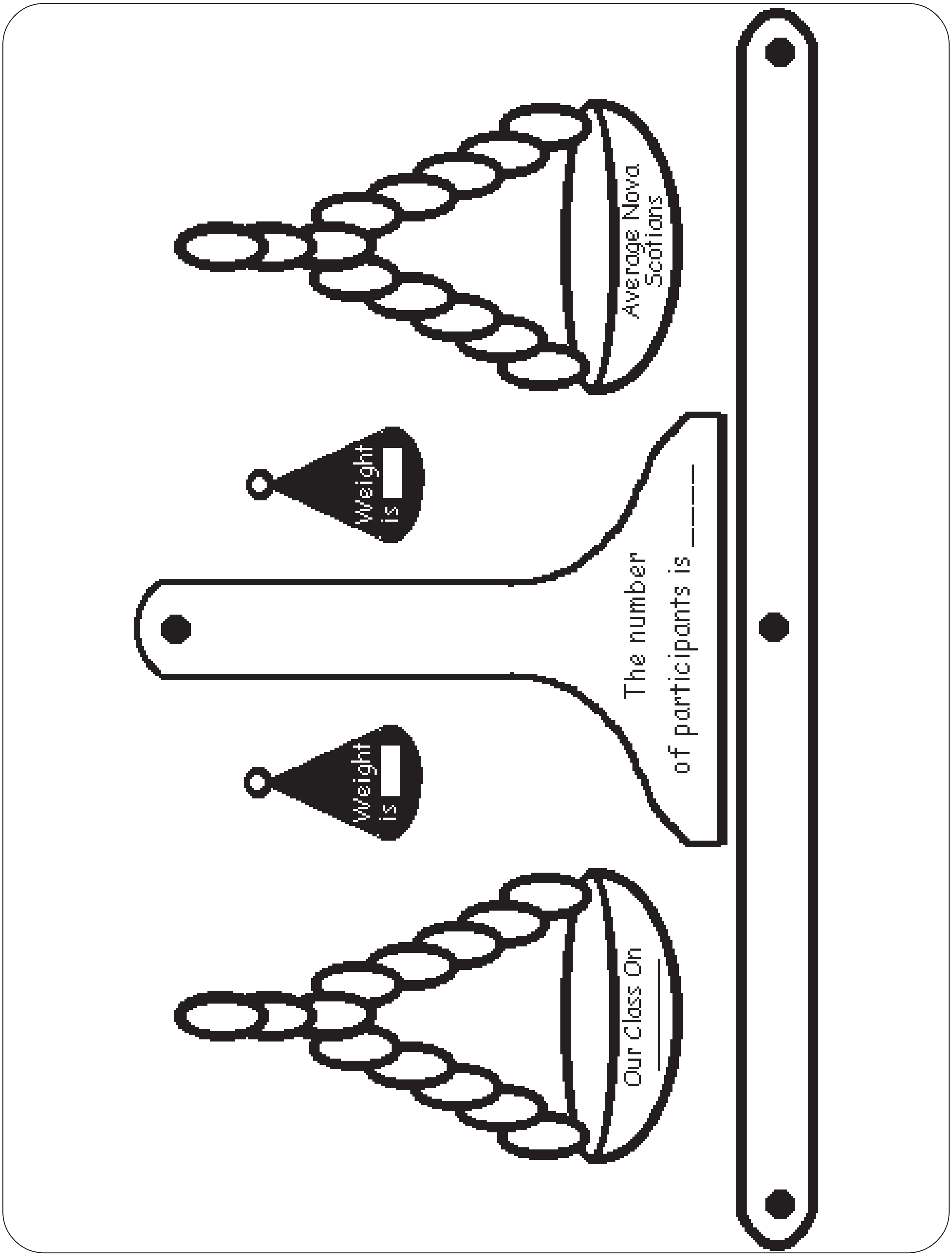
Out-of-Town Travel

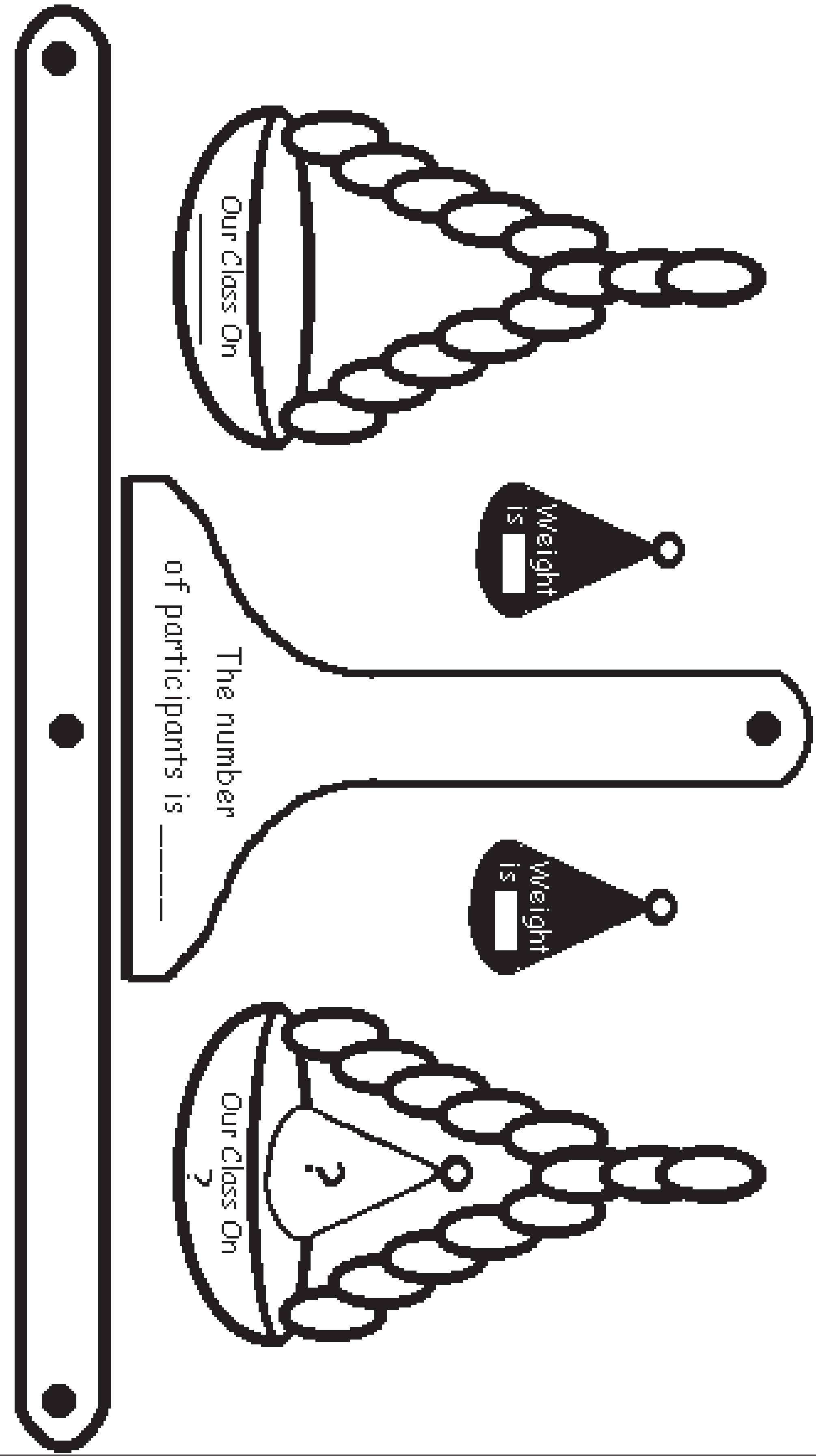


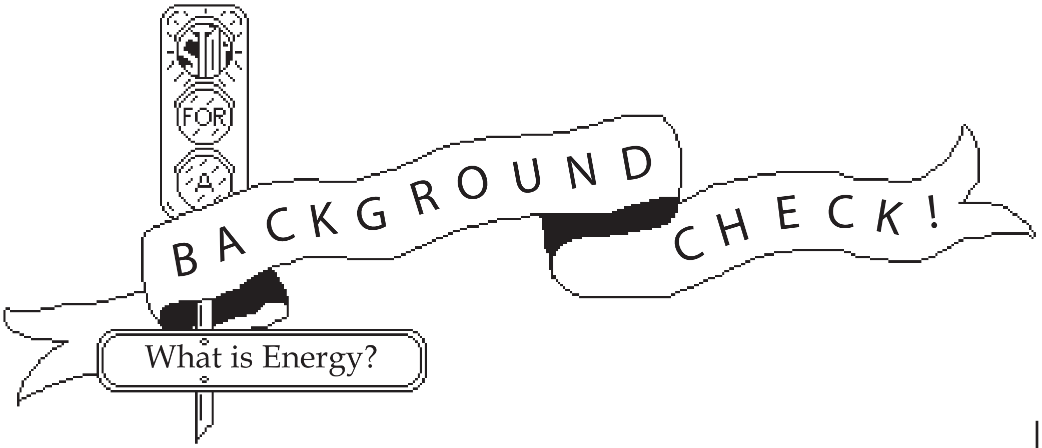
In the squares below, fill out how many annual trips your household makes of the following distance.

Below each one, write the types of transportation you use for that distance.

Less than 500 km	500 to 1000 km	1000 to 2400 km	More than 2400 km
☐	☐	☐	☐
__________	__________	__________	__________
__________	__________	__________	__________
__________	__________	__________	__________
__________	__________	__________	__________


Average Nova Scotians
Weight is
The number of participants is _____
Weight is
Our Class On ____

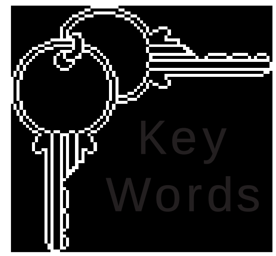

Our Class On ____
Weight is
The number of participants is ____
Weight is
Our Class On ?
?



Over time, energy has come to mean many things to us. In physical science, energy means the ability to do *work*. Work means a change in position, state, or form of matter (work = force x distance). Therefore, energy is the capacity to change matter.

Everything we do involves energy. Everything that happens in the universe, from the eruption of volcanoes, to the sprouting of seed, to the moving of people, takes energy. When we turn on a motor, drive a car, cook on a stove, or switch on a light, we are using energy.

Energy can produce motion, heat or light, but energy cannot be created or destroyed. However, it can be changed from one form into another. Changing energy back and forth from one form or state to another is how we control it for our use.



Energy, Work, Potential, Kinetic, Chemical, Electrical, Mechanical, Nuclear, Thermal

Potential and Kinetic Energy

Energy can be in one of two states: potential or kinetic. Energy can be transferred from potential to kinetic and between objects.

Potential energy is stored energy – energy ready to go. A lawn mower filled with gasoline, a car on top of a hill, and students waiting to go home from school are all examples of potential energy. Water stored behind a dam at a hydroelectric plant has potential energy.

Most of the energy under our control is in the form of potential energy. Potential energy can be viewed as motion waiting to happen. When the motion is needed, potential energy can be changed into kinetic energy.

Kinetic energy is energy at work. A lawn mower cutting grass, a car racing down the hill, and students running home from school are examples of kinetic energy. So is the light energy emitted by lamps. Even electrical energy is kinetic energy. Whenever we use energy to do work, it is in the kinetic state.

Forms of Energy

Energy comes in six forms: *chemical*, *electrical*, *light*, *mechanical*, *nuclear*, and *thermal*. These six forms of energy are all related. Each form can be converted or changed into any of the other forms. For example, when wood burns, its chemical energy changes into thermal (heat) energy and light energy.

Not all energy conversions are as simple as burning wood. An automobile converts the chemical energy in fuel into mechanical energy, the energy of motion, and into heat since the conversion is not 100% efficient.

Chemical Energy

Energy stored in the bonds between atoms in molecules is chemical energy. For example, in photosynthesis, plants take in energy from sunlight. This solar energy is stored in complex chemical compounds such as starches and sugars. The stored energy is released when these compounds break down into simpler compounds. The way to use the chemical energy in most fuels is by burning them, as we do with wood, natural gas, gasoline, coal, and others.

Electrical Energy

Electrical energy is the energy of moving electrons. It cannot be seen, but it is one of our most useful forms of energy because it is relatively easy to transmit and use. All matter consists of atoms, and every atom contains one or more electrons, which are always moving. When electrons are forced along a path in a conducting substance, the result is energy called electricity.

Electrical generating plants do not create energy, but rather change other forms of energy into electricity. Power plants can convert, for example, chemical energy of fuels into thermal energy, which evaporates water into steam, which produces mechanical energy as it moves through turbines. The turbines spin generators, which produce the electricity.

Light Energy

Light is produced when atoms absorb energy from an outside source and release (or “emit”) this energy as electromagnetic radiation. This radiation can be in the form of waves of many different wavelengths or frequencies. Many energy sources produce light. The sun is a luminous or “light-giving” object that produces and emits visible and invisible light from nuclear reactions. Luminescence may result from biological processes (e.g., fireflies), chemical reactions like burning wax from a candle, friction, or electricity (e.g., light bulb).

Mechanical Energy

Mechanical energy is the most familiar form of energy. It is the energy involved in moving objects. Every moving object has mechanical energy. Mechanical energy pulls, pushes, twists, turns, and throws. Machines use this energy to do work. Our bodies also use mechanical energy to perform motions.

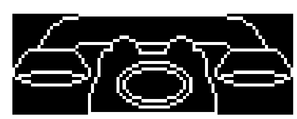
Nuclear Energy

A release of nuclear energy occurs when matter changes into energy. In a nuclear reaction, a small amount of hydrogen or uranium is changed into a huge amount of energy. Nuclear energy is released during atomic fission, when uranium atoms are split. It is also released during fusion, when hydrogen nuclei are combined. In fission and fusion, nuclear energy produces heat (thermal energy). Heat from fission is used to generate electric power in hundreds of locations worldwide. The sun and other stars use fusion to generate light and thermal energy.

Thermal Energy

Thermal energy is heat. It also involves motion. Normally, the motion of thermal energy is not visible, but we can feel or see the effects of heat. We use heat energy to cook our food and heat our homes, and we use it to generate electricity.

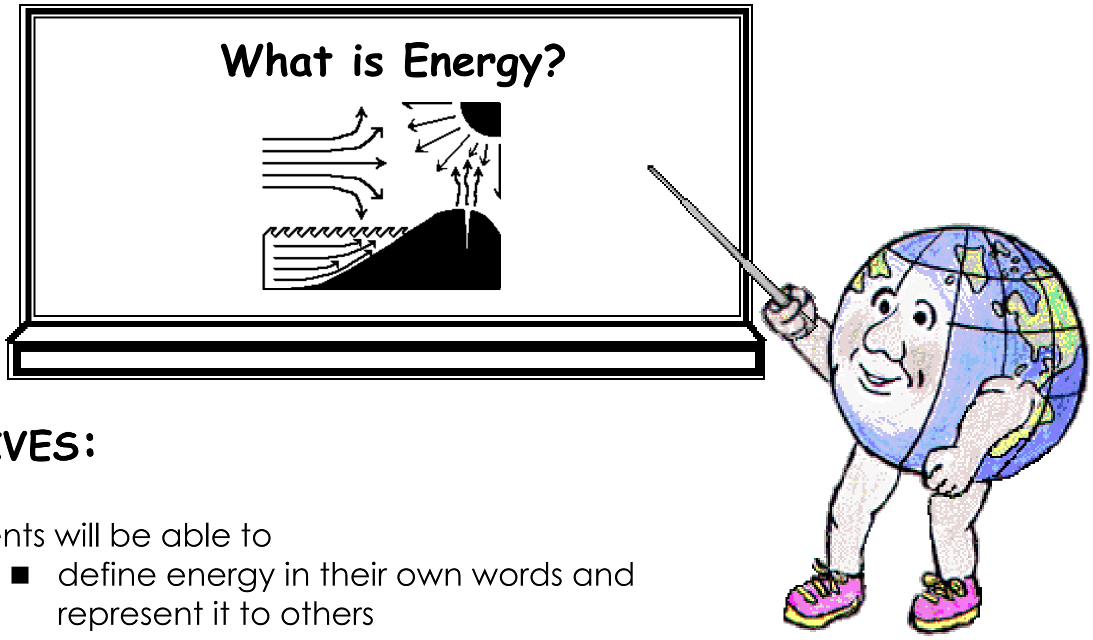
Heat energy is the energy of moving or vibrating atoms. Atoms and molecules are always in motion. The amount of heat energy given off by a substance depends on the speed and number of atoms or molecules in motion. The faster the atoms or molecules move, the higher the heat energy. Also, the more atoms or molecules that are in motion, the greater the quantity of heat they produce.



Source

Railroad Commission of Texas Energy Education
http://www.rrc.state.tx.us/divisions/afred/education/education.html

Energy : Lesson #1



OBJECTIVES:

Students will be able to

- define energy in their own words and represent it to others
- name different types of energy
- work cooperatively to categorize information about energy
- create a wall display of what they think energy is

MATERIALS:

Student activity sheet "What is Energy?: True or False", materials for bulletin board displays (paper, old magazines, staplers, markers, etc.), sets of cards in envelopes (enough for groups of 4) cut out from the "Energy Cards" sheet

PROCEDURE:

INTRODUCTION:

What is energy? T/F

Students will complete an activity sheet with true and false questions to get them thinking about energy. Be certain to stress that it is just an activity to get our brains in thinking mode and not a test. Students are to complete only the "Before" section.

(It may be useful for the teacher to collect these papers simply to see what pre-conceptions and possible misconceptions the students may have.)

MAIN ACTIVITY:

Divide the class into groups of approximately 4 students each. Have the cards cut out of the attached sheet and placed into envelopes. Each group receives an envelope containing a full set of cards. The cards are randomly dealt out as evenly as possible among the group members. The students must group the cards by category. Only the student who was dealt the card is permitted to handle it. Group members may ask others to read out their cards, but they may not handle the cards of others. In order to complete the task, students must work together cooperatively.

NOTE: To make the exercise more challenging, you can remove the cards that have the category names and have students sort the cards and create a name for each category.

Each block of the table below represents
a correctly placed card from the set.

Category 1	Category 2	Category 3	Category 4
Types of Energy	Energy Rules	Energy Uses	Some things that would not exist without energy
Light	Energy can not be created.	Movement	Sun
Chemical	Energy can not be destroyed.	Creating heat	Wind
Nuclear	We can not survive without energy.	Human growth	Humans
Electrical	Energy always breaks down into a simpler form from a more complicated one.		Moving water
Heat			

This is an excellent opportunity to assess cooperative skills. Look at assessing skills such as asking politely, waiting one's turn, encouraging others, etc. Remember that these skills must be reviewed with students prior to beginning the activity if one is going to assess.

After a predetermined time (e.g. 10 minutes), the class goes over their answers. Write the categories on the board and have students verify their group's answers.

Students return to their true and false activity sheet and redo the questions based upon the facts they have discovered in the "Sort the Cards" activity. Students mark their answers in the "After" section.

Now is an excellent time to ask students to define energy. Conduct a brainstorming activity (see lesson 4 for brainstorm rules) and have students come up with their own definitions. Make sure to add a universally accepted definition before the students move on to the next activity. Discuss with the class how their definitions are similar or differ. Here is a useful definition to use:

> "Energy is the capacity or ability to do work. In organisms, the biological work that requires energy includes processes such as growing, moving, reproducing, and maintaining and repairing damaged tissues. Energy exists in several different forms: chemical, radiant (light), heat, mechanical, nuclear, and electrical. Energy can exist as stored energy - called potential energy - or as kinetic energy, the energy of motion."
>
> Environment (2nd ed.), Raven, Berg, and Johnson, 1998, p. 47

CONCLUSION:

1. Students return to the groups they were in for the "Sort the Cards" activity. Each group is given the task of representing what they think energy is. Groups are given a specified amount of space (wall or bulletin board) to show "energy" in words and/or pictures.

2. As a summing up of the day's learning and as a way to move on to other lessons on energy, ask the students why they think we are learning about energy.

Some possible answers

- to understand where it comes from
- to learn how to use it efficiently to reduce pollution and greenhouse emissions
- to better understand how our community and world function

Additional Activities

Language Arts:

- Read a favourite story (as a class or individually). Make a list of all the examples of energy use in the story according to the type of energy.

The Arts:

- The groups could represent their perception of energy in drama or music form.
- They could also have the groups create 3 dimensional wall displays for the previous activity.

Energy Cards

Energy Uses	Chemical	Energy can not be created.	Heat
Human growth	Nuclear	Some things that would not exist without energy	Movement
Wind	Energy can not be destroyed.	Sun	We can not survive without energy.
Humans	Creating Heat	Electrical	Moving Water
Types of Energy	Energy Rules	Light	Energy always breaks down into a simpler form from a more complicated one.

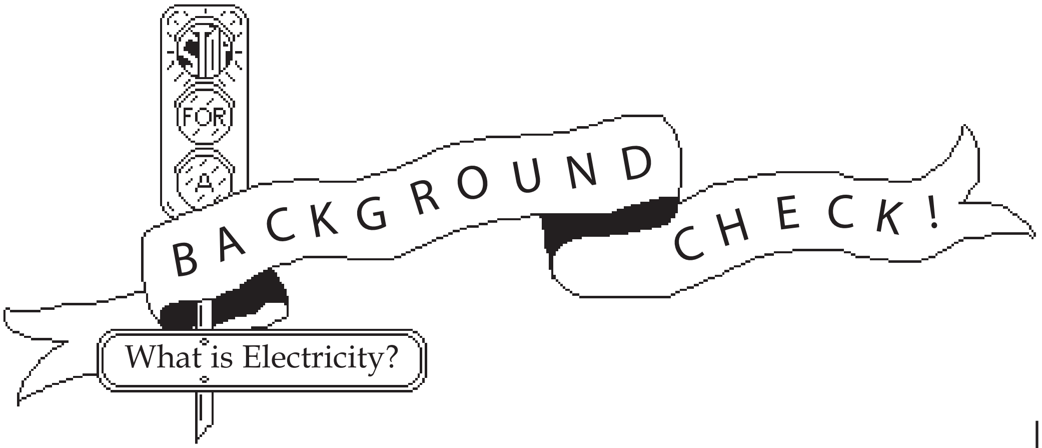
Name : ______________________

Date : ______________________

What is Energy?: True or False

Answer the true or false questions to the best of your ability by marking a check in the box.

Questions	Before Activity: True	Before Activity: False	After Activity: True	After Activity: False
1. Energy only comes from the sun.				
2. There is only one kind of energy.				
3. Energy is something you can touch.				
4. Energy can be used up.				
5. Energy can be stored.				
6. Humans need energy to survive.				
7. Growing uses energy.				
8. Heat is a type of energy.				



The energy form **electricity** is looked at more closely in the next lesson entitled "What is Electricity?" Within the lesson there is a comic book page entitled "Louie the Lightning Bug's Power Tour." This was adapted from a comic book created by Nova Scotia Power to promote knowledge of how electricity is generated in Nova Scotia.

The following background information about electricity was compiled from information available from the Manitoba Conservation of Energy.

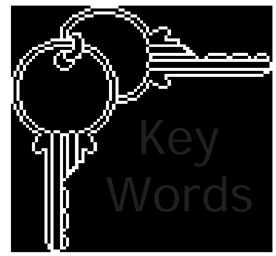
What is Electricity?

In technical terms, *electricity* is the form of energy resulting from the movement of charged particles (electrons) in a conductor such as a copper wire.

One way to produce electricity is to move a wire through a magnetic field. By passing several coils of wire quickly and continuously through the field of a powerful magnet, a great quantity of electrical current can be produced. An energy source is needed to move the coils through the magnetic field or move the magnetic field through the coils.

In a hydroelectric generating station, flowing water spins a *turbine* connected to a *generator* where a moving magnetic field creates an electric current in surrounding coils. The amount of electricity that can be generated varies with the energy available to spin the turbine. The amount of energy available depends on the height of the waterfall and the volume of water passing over the fall.

If flowing water is not available, turbines can be turned by steam pressure. The steam is created when water is heated by the burning of coal or oil. Once in the form of electricity, the energy can then be distributed to homes and businesses across the province through a system of transmission and distribution lines.

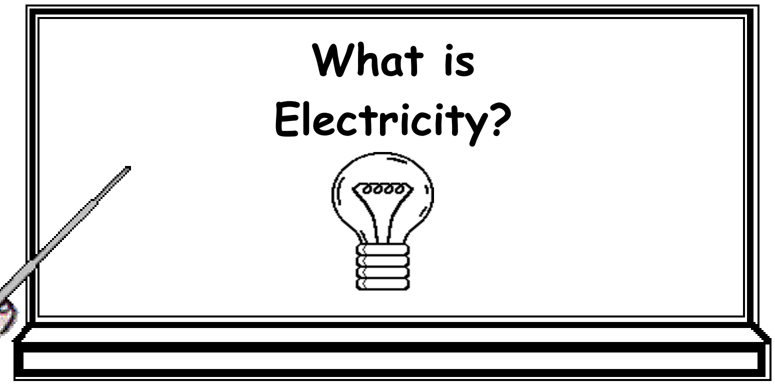


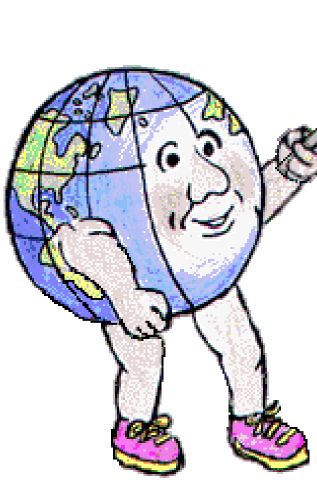
Electricity, Generator, Turbine

Sources

NSPower
(902) 428-6230
http://www.nspower.ca/

Energy : Lesson #2





OBJECTIVES:

Students will be able to

- identify and explain the steps in the process of generating electricity from fossil fuels in Nova Scotia
- know and use the vocabulary associated with the process, such as fossil fuel, generator, turbine, transformer
- play "Roll your way to Power"
- participate in a Human Scavenger Hunt

MATERIALS:

Copies of "Human Scavenger Hunt: Electricity" for each student, copies of "Louie the Lightning Bug's Power Tour", copies of "Electricity: From Coal to You" sequential organizer for each student, dice (one for each group of 4), "Roll your way to Power" game sheet for each student

PROCEDURE:

INTRODUCTION:

In this lesson, students will learn about the process of generating electricity in Nova Scotia. They will read a comic book story about the process and then put the steps into their own words using a sequential organizer.

Distribute copies of "Human Scavenger Hunt: Electricity." Explain to students that they must try to find someone in the class for each one of the clues, but that each person can only sign each page one time. For example, if Andrew's aunt works at NSPower and he signs Jennifer's paper, he can not sign again to say that he has changed a light bulb or any of the other clues. If it is a clue that requires that the person know an answer, the answer must be written with the person's signature. Give students a limited amount of time or until 2 people have found all the clues. Go over the class' discoveries before moving on to the next part of the lesson.

MAIN ACTIVITY:

Students read the comic book page "Louie the Lightning Bug's Power Tour". Have them make note of any new words or words they did not understand. When they have finished reading discuss it with the class. Here are some discussion questions to expand the discussion into other concepts.

- Where does electricity come from in Nova Scotia? (fossil fuels, tides, wind)
- What do we know about coal? About tides? About wind?
- How does electricity get to your home?
- What effects does generating electricity have on the environment? (run-off pollution from coal mining, greenhouse emissions from burning of coal, difficulty in disposing of coal ashes, changing temperature of water can affect plant and animal life (cooling process for condenser), impact of mining on habitats and biodiversity, etc.)

Go over the words that students did not understand. Add these to the class glossary of new words or make a word corner in the classroom with each of the words and a short definition written on colourful paper.

Some words that may cause difficulty are:
- Turbine - Generator - Voltage

The class will complete a sequential organizer showing the steps to generate electricity in Nova Scotia. Let students know that for this activity, they will be using the process that begins with fossil fuels even though there are other methods that exist. Students are to complete the organizer in their own words. Encourage students to draw pictures of things that are difficult to explain.

CONCLUSION:

<u>Roll Your Way to Power</u>

Divide the class into small groups (3-5 players per group). Each group receives a die. Each player receives a game sheet. The players take turns rolling the die. Each player must roll a 1 to achieve the first step in the process, a 2 to achieve the second step and so on. The first player to achieve all six steps, wins the game and gets to roll again in the next game.

ADDITIONAL ACTIVITIES

MATHEMATICS:

- Use "Roll your way to Power" as a way to move into lessons on probability.

LANGUAGE ARTS:

- Have the students write a story in the first person, imagining that they are a unit of energy: starting from being trapped in the ground with coal and then travelling into their home via power lines for daily use.

VISUAL ARTS:

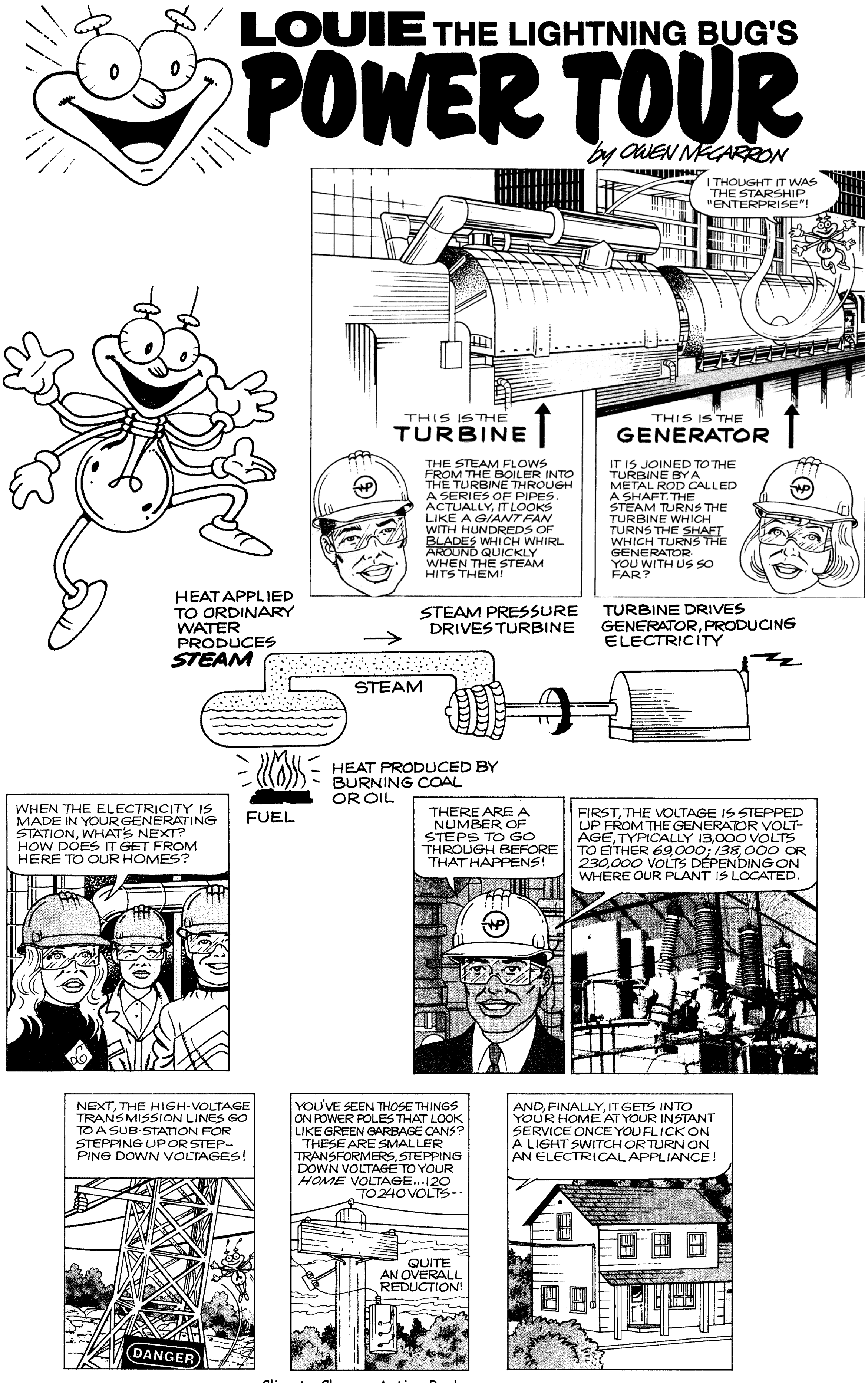
- Have a guest speaker in from Nova Scotia Power to speak to the class about power safety or about their job.

Name: ____________
Date: __________

Human Scavenger Hunt:
ELECTRICITY

Find someone that…

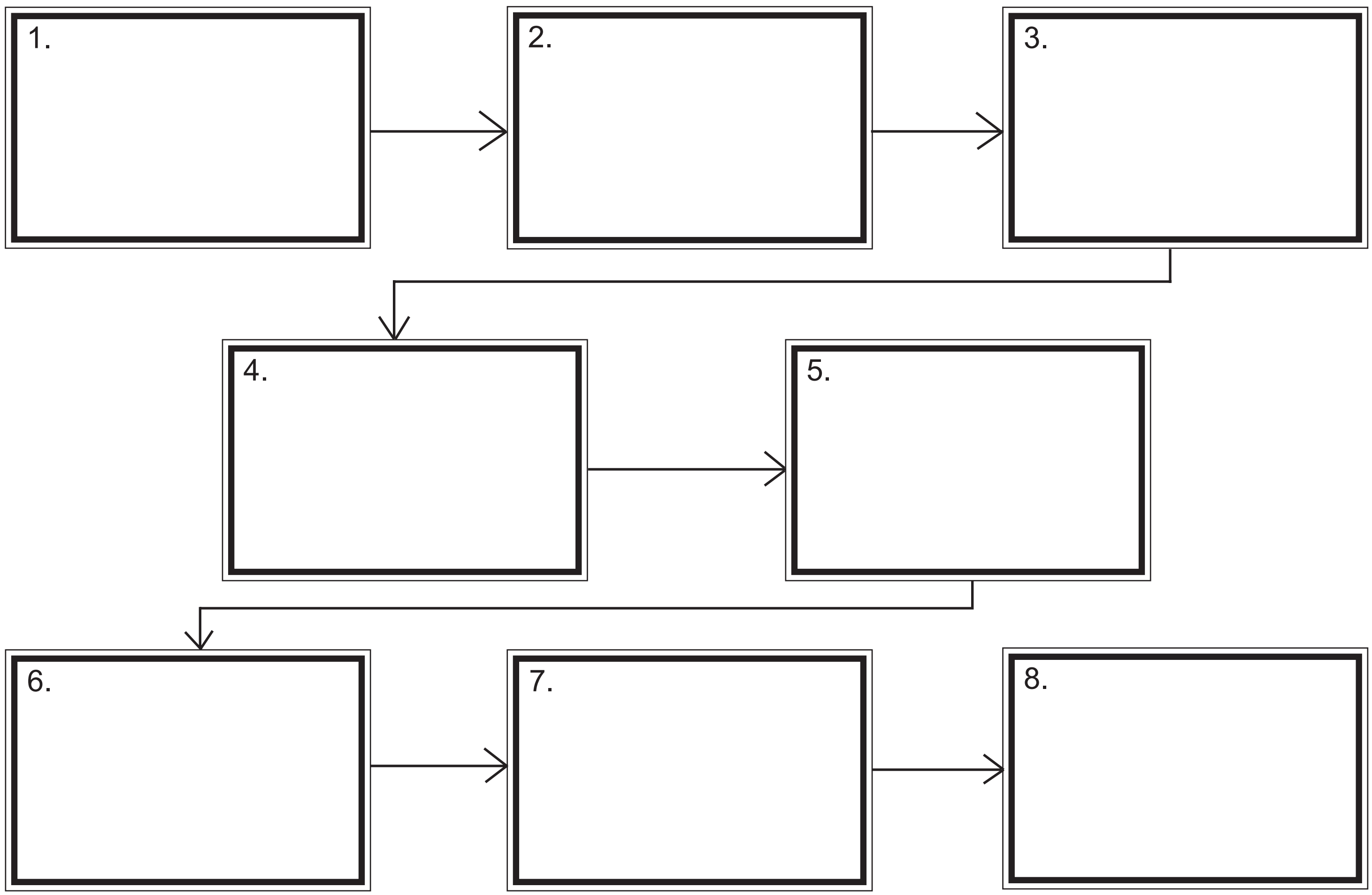
Has walked along a trail cut for power lines ____________	Has changed a light bulb ____________	Has a light on their home that turns on at night automatically ____________	Has seen a power generating plant ____________
Can name one place in N.S. where electricity is made using tides ____________ ans: _________	Knows someone who works for NSPower ____________ ans: _________	Decides what they want before they open the refrigerator ____________	Can name one type of renewable energy ____________ ans: _________
Has seen a "Danger: Keep Out" sign on a electrical sub-station ____________	Knows where the electric meter is at their house ____________ ans: _________	Can name a fossil fuel that NSPower burns to make electricity ____________ ans: _________	Turns off the lights every time they leave the room ____________
Puts on a sweater instead of asking an adult to turn up the heat ____________	Has had the power go out at their house ____________	Knows what a volt is ____________ ans: _________	Has a streetlight right in front of their house ____________


LOUIE THE LIGHTNING BUG'S
POWER TOUR
by OWEN McCARRON
I THOUGHT IT WAS THE STARSHIP "ENTERPRISE"!
THIS IS THE TURBINE
THE STEAM FLOWS FROM THE BOILER INTO THE TURBINE THROUGH A SERIES OF PIPES. ACTUALLY, IT LOOKS LIKE A GIANT FAN WITH HUNDREDS OF BLADES WHICH WHIRL AROUND QUICKLY WHEN THE STEAM HITS THEM!
THIS IS THE GENERATOR
IT IS JOINED TO THE TURBINE BY A METAL ROD CALLED A SHAFT. THE STEAM TURNS THE TURBINE WHICH TURNS THE SHAFT WHICH TURNS THE GENERATOR. YOU WITH US SO FAR?
HEAT APPLIED TO ORDINARY WATER PRODUCES STEAM
STEAM PRESSURE DRIVES TURBINE
TURBINE DRIVES GENERATOR, PRODUCING ELECTRICITY
STEAM
HEAT PRODUCED BY BURNING COAL OR OIL
FUEL
WHEN THE ELECTRICITY IS MADE IN YOUR GENERATING STATION, WHAT'S NEXT? HOW DOES IT GET FROM HERE TO OUR HOMES?
THERE ARE A NUMBER OF STEPS TO GO THROUGH BEFORE THAT HAPPENS!
FIRST, THE VOLTAGE IS STEPPED UP FROM THE GENERATOR VOLTAGE, TYPICALLY 13,000 VOLTS TO EITHER 69,000; 138,000 OR 230,000 VOLTS DEPENDING ON WHERE OUR PLANT IS LOCATED.
NEXT, THE HIGH-VOLTAGE TRANSMISSION LINES GO TO A SUB-STATION FOR STEPPING UP OR STEPPING DOWN VOLTAGES!
DANGER
YOU'VE SEEN THOSE THINGS ON POWER POLES THAT LOOK LIKE GREEN GARBAGE CANS? THESE ARE SMALLER TRANSFORMERS, STEPPING DOWN VOLTAGE TO YOUR HOME VOLTAGE...120 TO 240 VOLTS--
QUITE AN OVERALL REDUCTION!
AND, FINALLY, IT GETS INTO YOUR HOME AT YOUR INSTANT SERVICE ONCE YOU FLICK ON A LIGHT SWITCH OR TURN ON AN ELECTRICAL APPLIANCE!

Name: ____________________
Date: ____________________

Sequential Organizer

Electricity: From Coal to You



Sequential Organizer
Electricity: From Coal to You
(Teacher's Copy)

1. Burning coal produces heat.
2. Heat turns water to steam.
3. The steam pressure drives the turbine.
4. The turbine drives the generator which produces electricity.
5. The voltage is stepped up to transmission line voltage (at least 69 000 volts).
6. The electricity travels through high voltage transmission lines to the substation for stepping up or down voltage.
7. The electricity travels to smaller transformers (on power poles) to be stepped down to household voltage (120 or 240 volts).
8. The electricity travels into your home to be used on demand.

Name: ______________ Date: ____________________

ROLL YOUR WAY TO POWER
GAME SHEET

You must roll the corresponding number on the die
to achieve each step in generating electricity!

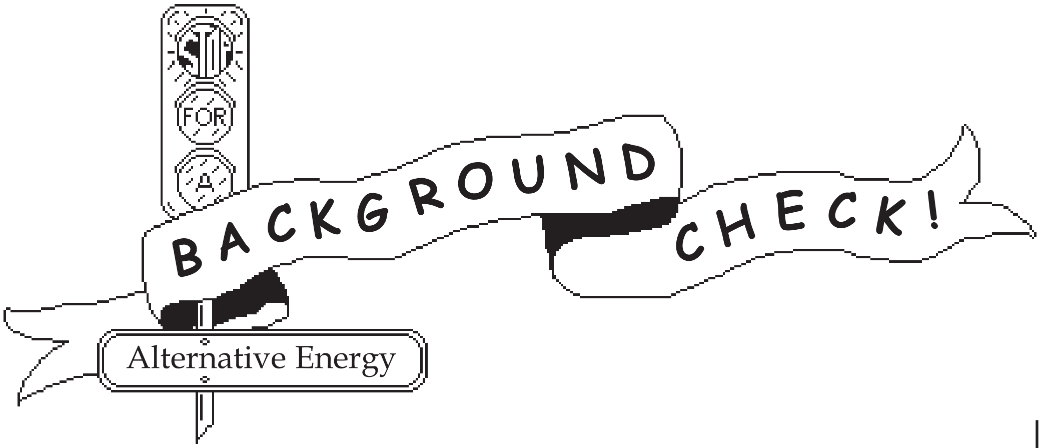
Game #	Step 1 Mine and process coal	Step 2 Burn coal to produce heat	Step 3 Heat water and turn it to steam	Step 4 Steam pressure drives turbine	Step 5 Turbine drives the generator	Step 6 You have electricity!
1						
2						
3						
4						

Name: ______________ Date: ____________________

ROLL YOUR WAY TO POWER
GAME SHEET

You must roll the corresponding number on the die
to achieve each step in generating electricity!

Game #	Step 1 Mine and process coal	Step 2 Burn coal to produce heat	Step 3 Heat water and turn it to steam	Step 4 Steam pressure drives turbine	Step 5 Turbine drives the generator	Step 6 You have electricity!
1						
2						
3						
4						



The primary energy sources used today are fossil fuels. All other sources of energy are called alternative energy. Alternative energy can be renewable or nonrenewable. Here are some of the alternative energy sources along with the bad and good news that comes with each energy source.

Geothermal Energy

Geothermal energy is the useful conversion of natural heat from the interior of the Earth to heat buildings and to generate electricity. This type of power is being used presently in Russia, Iceland, and California. It is only considered to be nonrenewable when used at greater extraction rates than natural replenishment.

Bad News : The environmental impact of geothermal energy is not as extensive as other sources of energy but it is considerable. Environmental problems include on-site noise, emissions of gas, and disturbance of the land for the site and pipes. As well, the production of energy and electricity from geothermal reservoirs is rather expensive and only applicable in limited areas. Some cultures, Hawaiin for example, are offended by the use of an underground source for energy.

Good News : Development of geothermal energy does not require large-scale transportation of raw materials. It does not produce the pollutants that burning fossils fuels does or the problems associated with storing radioactive waste.

Direct Solar Energy

The total amount of solar energy reaching Earth's surface is tremendous. Would you believe that about 10 weeks of solar energy is roughly equivalent to the energy stored in all known reserves of oil and natural gas on the whole planet! However, the actual amount of energy at any particular site varies with the time of year and cloud cover.

Solar energy is used directly through passive and active solar energy systems. Passive systems take advantage of natural solar changes throughout the year without requiring mechanical power. For example, some houses are designed with windows to let in the rays of the winter sun but are shaded from the summer sun's more direct rays. Active systems require mechanical power, such as pumps to circulate air water from solar collectors to a heat sink where it is stored. Photovoltaics is a technology that converts sunlight directly into electricity using a semiconductor material. Solar towers are sometimes constructed to collect the heat of solar energy and deliver its energy in the form of steam to turbines that produce electric power.

Alternative Energy, Renewable, Nonrenewable, Geothermal, Solar, Hydrogen, Water, Wind, Biomass

Good News: Solar energy generation has a relatively low impact on the environment, and the raw material, sunlight, is free. In Nova Scotia, solar energy is gaining use in homes and businesses, but is not yet being used for larger-scale electrical generation in Nova Scotia.

Bad News: A large land area is required to generate large amounts of solar energy. Also, the start-up materials can be expensive, and require the manufacturing of plastics and metals.

Natural Gas

Natural gas is used for heating, cooling and production of electricity. It is a colourless, odourless fuel. It consists mainly of methane (one carbon atom and four hydrogen atoms) and burns more cleanly than many other traditional fossil fuels.

Good News: Natural gas is widely available and easily transported. It is efficient and burns more cleanly than coal and oil (and so has lower CO_2 emissions).

Bad News: Even though natural gas burns more cleanly, it still has emissions. It is a non-renewable resource, and reserves will be exhausted before coal reserves run out. Mines and pipelines required to obtain and transport natural gas can disrupt ecosystems.

Water Power

Hydro power converts the energy in flowing water into electricity. The amount of electricity generated is determined by how much water is flowing and the distance from the turbines in the power plant to the water's surface. The water rotates the turbines, which drive generators that produce electricity.

Good News: Water power is reliable and capable of generating large amounts of power It is renewable, releases no CO_2 emissions, and is currently inexpensive.

Bad News: Dams can cause disruption to aquatic and terrestrial ecosystems. Also, water that falls over dams picks up nitrogen gas. This nitrogen enters the blood of fish, expands and kills the fish. Locations can be difficult to come by and are subject to changing conditions (such as drought).

Wind Power

Wind power is the using the kinetic energy of the wind which has been transformed into mechanical or electrical energy and harnessed for practical use.

Good News: Wind energy has no emissions and is abundant and renewable. Turbines can generally be set up with minimal impact to ecosystems.

Bad News: Energy production is dependant on wind speed, and is only feasible in areas with sufficient amounts of wind. Wind farms require relatively large amounts of land, and there is some opposition to turbines and wind farms based on potential aesthetic, noise-related, and environmental impacts.

Energy from Biomass

Biomass fuel is simply organic matter such as plant materials and animal waste. It can be burned directly or converted to a more convenient form. Wood was the major source of fuel in North America until the end of the 1800's. Firewood, peat moss, cattle dung are other forms of biomass energy.

Good News: When used sustainably, biomass is a renewable source of energy. Plentiful sources in waste products (from agriculture, forestry and food processing). It is a proven technology, and is not dependant on fossil fuels. Burning biomass produces less CO_2 than burning fossil fuels.

Bad News: Processing biomass can pollute the air and degrade the land and water. If they are used or harvested to quickly, some sources of biomass fuel will not be able to be renewed. Using wood as a fuel affects habitats and wildlife.

Source

INDEPTH: ENERGY
Sources of Energy
CBC News Online
May 20, 2004
http://www.cbc.ca/news/background/energy/sources.html

Re-Energy
www.re-energy.ca

Energy : Lesson #3

Objectives:

Students will be able to

- complete a q-sort
- prepare and present an energy form to the class
- evaluate their work as a group
- form personal opinions about the merits of various energy sources

Materials:

Class set of "Student Q sort – Alternate Energy Forms", small slips of paper (same approximate size as blocks on Q sort organizer), Energy cash ($100 per student in $10 allotments), poster board or chart paper, research materials (bookmarked web sites, encyclopedias, information pamphlets), small containers (one for each energy form presented), "Evaluation of Student Presentation" group and teacher copies

Procedure:

Introduction:

Students will examine alternative forms of energy. They will prepare a poster presentation in groups of three, present their findings to the class, and assess their work. Students will also make a personal decision on which type of energy they feel is best for themselves, society, and the environment.

1. Think-Pair-Share

Students will use Think-Pair-Share strategy to think of as many alternative energy sources as possible. The strategy is the 3-step process detailed below.

Think - Individual students are asked to think of as many alternative sources of energy as possible (time limit: 2 minutes).

Pair - Students turn to their partners/seatmates and share their answers.

Share - Students share their ideas with the entire class. The class' findings are recorded on chart paper for future reference.

*The teacher may need to add those energy sources that were not thought of by the class. (See list in Main Activity section.)

2. Q-sort

The students are given a copy of the Q-sort worksheet. They are asked to write the name of an alternative energy source on each of their slips of paper. Then they are to arrange them on the Q-sort organizer. They are to order them from the one they think is the "worst" alternative energy (left) to the "best" (right). Once they have the slips in their desired locations, they remove the slips and record the source in the corresponding block.

MAIN ACTIVITY:

Students are divided into groups of three. Each group is assigned a form of energy.

Biogas	Fossil Fuels	Solar
Biomass	Geothermal	Tidal
Chemical*	Hydrogen fuel cell*	Wind
Coal	Nuclear	Natural Gas

*These energy sources are more difficult to research. They could be removed to make group numbers even or given to students in need of a challenge.

Inform the class that they are the presentation teams for alternative energy companies. They must create presentations for the Atlantic Alternative Energy Conference. This conference is specifically for people who want to invest in new companies.

The presentation must include:

- the company's name (must reflect the company's form of energy)
- where the energy comes from (bonus point for diagram)
- the pros and cons of the energy's use (minimum of 3 for each)

Tell them that they are to pretend that they are trying to convince the potential stockholders to invest because they possibly represent the money that will be the company's paycheck. The presenter can not lie to the stockholders, as that would be fraud. They must also remember to use their best presentation skills, including a clear voice and well-organized information, in order to convince them. (Handout the "Evaluation of Student Presentation: Group Copy" to the groups and explain the assessment grid to the students prior to them beginning their work.)

CONCLUSION:

1. Evaluation

Students will complete the group evaluation form. Remind the students that they do not have to only give marks that are whole numbers. Decimals allow a better range of marks and therefore a more accurate portrayal. For example, the marker should not be only given the choices 0% (0/2), 50% (1/2), or 100% (2/2) for the name of the company. Remind them though that they receive full value if the criteria are completely and correctly fulfilled.

2. Q –Sort Reprise

Each student is asked to return to his or her Q-sort. They re-evaluate the various forms of energy and rank them according to the new information they have learned from their classmates' presentations.

3. Investment

Each student receives $100 of energy cash. They must now decide in which company they wish to invest their imaginary "hard-earned cash". Tell them that it is not necessary to spend all of their money on one company. Students are given five minutes to decide on their investments. They are then asked to place their investments in the container labeled for each of the energy sources. The presentation teams for each energy source count the invested cash and the amounts are posted for the class.

Here are some points for them to ponder when investing:

- Does this form of energy meet my needs?
- Does this form of energy work well in my area of the world?
- Does this company reflect my own environmental beliefs?

ADDITIONAL ACTIVITIES

MATHEMATICS:

- Use the data from the investment section of the lesson to do graphing exercises (pie or bar graphs).

LANGUAGE ARTS:

- Have students write a project report to the President of their fictional company which summarizes the finer points of their presentation and details the success/failure of their presentation. Use a process writing approach in triads or individually.
- Have students play the Human Scavenger Hunt game included with this lesson to work on asking questions and communication skills.

VISUAL ARTS:

- Have students make commercials for their investors instead of a live presentation. Record these with a video camera and play them in class.

SOCIAL STUDIES:

- Using maps of Canada and of the world, have students find and mark the locations where the various energy sources are used. Have each group research their own energy source. Once all the energy sources are researched, have the groups display their findings together on a giant wall map inthe classroom or hallway. Don't forget to have the students include a legend for the energy symbols.

Name: ____________
Date: __________

Human Scavenger Hunt:
FORMS OF ENERGY

Find someone that…

Uses solar power to heat their home _____________	Has a propane barbecue _____________	Has visited a windmill _____________	Can name the type of energy that comes from burning waste _____________ ans: __________
Knows the term for using water to create energy _____________ ans: __________	Uses an energy source other than electricity at their home _____________ ans: __________	Can name 5 alternative energy sources _____________ ans: __________ _______________	Can name a nuclear disaster _____________ ans: __________
Can name the energy source being explored by the Sable Offshore Energy Project _____________ ans: __________	Can name four oil companies _____________ ans: __________ _______________ _______________	Knows the two ways of getting nuclear energy _____________ ans: __________	Has seen a waterwheel _____________
Can name a country that uses geothermal power _____________ ans: __________	Can name the body of water in Nova Scotia used for tidal power _____________ ans: __________	Has used a camp stove _____________	Can name the fossil fuel mined in Cape Breton _____________ ans: __________

Name: ________________
Date: ______________

Student Q-Sort
Alternate Energy Forms

Rank the energy sources from best to worst (left to right) according to your opinion.

Before

After

Give one reason why your q-sort changed or did not change.

____

____

____

Evaluation of Student Presentation: Teacher

Company Name: ____________________________
Presentation Team: _________________, ________________, ________________

Requirements	Point value	Mark	Comments
Name of Company	2		
Where does energy come from?	2 + 1		
Pros (min. of 3)	3		
Cons (min. of 3)	3		
Presentation skills (good voice, clearly presented material, all group members participated, use of scientifically appropriate terminology)	5		

Evaluation of Student Presentation: Teacher

Company Name: ____________________________
Presentation Team: _________________, ________________, ________________

Requirements	Point value	Mark	Comments
Name of Company	2		
Where does energy come from?	2 + 1		
Pros (min. of 3)	3		
Cons (min. of 3)	3		
Presentation skills (good voice, clearly presented material, all group members participated, use of scientifically appropriate terminology)	5		

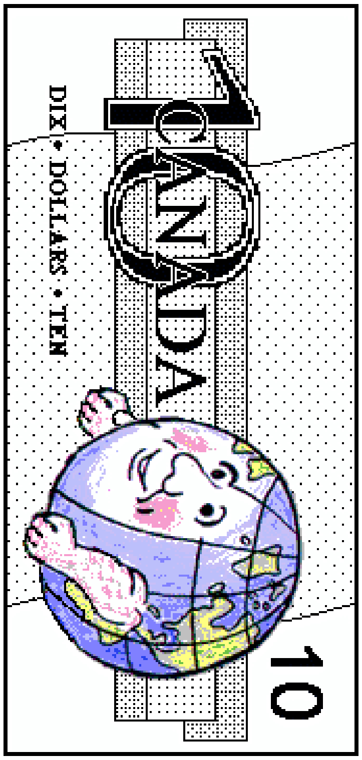
EVALUATION OF STUDENT PRESENTATION: GROUP

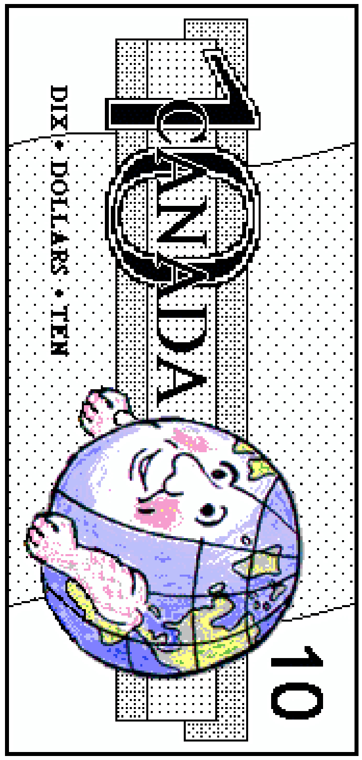
Company Name: ____________________________
Presentation Team: (your name first) ____________________________
____
____

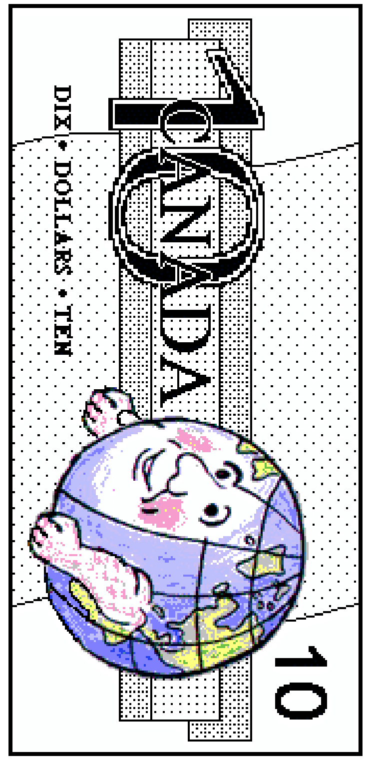
The evaluation must be completed by all group members.

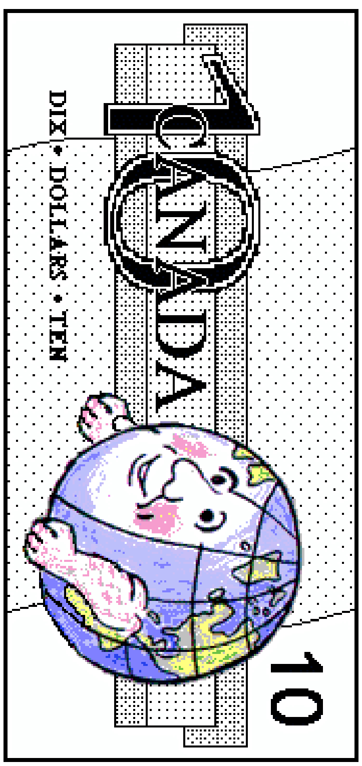
REQUIREMENTS	POINT VALUE	MARK	COMMENTS
Name of Company - Did we have one? - Did it represent the energy source?	2		
Where does energy come from? - correct information - 1 bonus point for diagram	2 + 1		
Pros (min. of 3) - Did we have 3 correct and convincing pros?	3		
Cons (min. of 3) - Did we have 3 correct and convincing cons?	3		
Presentation skills - Did we use the right volume? - Did each group member have a part in the presentation? - Was our information organized? - Did we use scientifically appropriate words?	5		

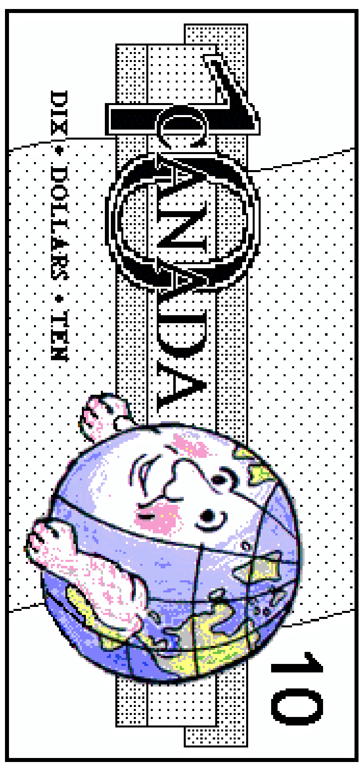
You receive full value if the criteria are completely and correctly fulfilled.

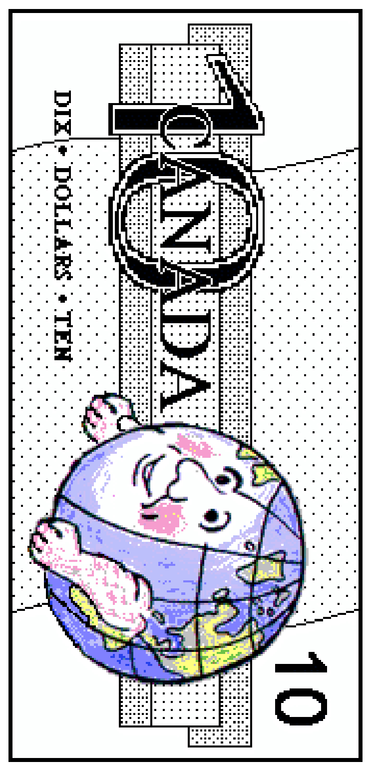

CANADA
DIX • DOLLARS • TEN
10

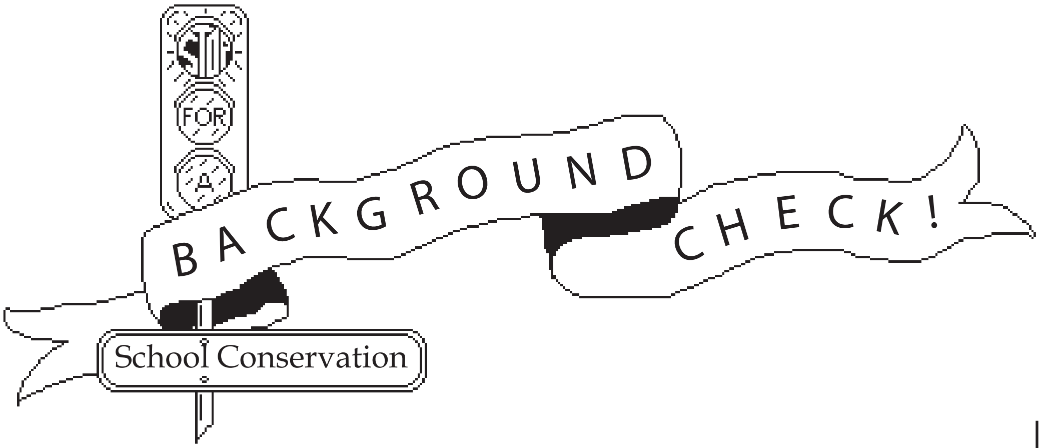

CANADA
DIX • DOLLARS • TEN
10


CANADA
DIX • DOLLARS • TEN
10

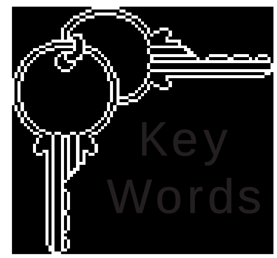

CANADA
DIX • DOLLARS • TEN
10


CANADA
DIX • DOLLARS • TEN
10


CANADA
DIX • DOLLARS • TEN
10



The following lesson looks at energy conservation in schools. Included in the lesson are a few energy audits taken from the Destination Conservation Project. Following is a backgrounder that was adapted from the project's web site (www.dcplanet.ca) where you can go to find out more information on how to become further involved.



Destination Conservation, Resources, Educational Support, Saving Money, Retrofit, Partnerships

What is Destination Conservation?

Destination Conservation (DC) is an innovative school based conservation program where students, staff, school district staff, and utility companies interact to initiate environmental education and conservation activities. The DC Program will involve students and staff in conserving energy and resources in their schools. The program educates students, retrofits schools, and saves money.

DC believes that you can't afford not to retrofit. They ensure that participating in the Destination Conservation Program will save the earth's resources and save you money at the same time. There are four cornerstones of DC: conserving resources, providing educational support, saving money, and promoting partnerships.

Conserves Resources

The Destination Conservation program involves students in auditing the school's consumption of energy and water. Students monitor the amount of waste generated. Working with school staff and parents, students develop a detailed conservation campaign for their school. Through monitoring changes in their school's use of resources, students gain an appreciation for how lifestyle changes in their school can make a big difference in utility bills as well as preserving our natural resources.

The two major ways the DC program helps people make a positive impact are by reducing pollution and by saving resources. For example, a school district with 5,000 students was able to reduce its water consumption by the equivalent of four swimming pools worth of water in one year!

Educational Support

The DC program provides information on energy, water and waste reduction, school audits and action plans, and student conservation campaign activities. There are two main resource types: resource manuals, and computer instruction. The DC resource manuals include the DC Program Manual, the Teacher's Resource Manual, and the School Conservation Team Manual. The DC computer instruction comes in the format of computerized student audits, and the web site (www.dc.ab.ca).

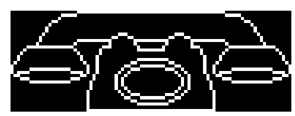
Saves Money

The Destination Conservation program has saved participating schools in Alberta more than $770,000. A typical school can expect to save up to 30 per cent or about $2,000 per year on their utility bills. Part of the savings go towards paying for the retrofits that are needed to make the school more energy, water and waste efficient. Some of the savings pay for the Destination Conservation program. And some of the savings free up resources so budget-squeezed schools can continue to provide quality education programs in the future.

The DC program is paid for by either an Energy Performance Contract with an Energy Services Company, or by a self-administered school district program. The Energy Performance Contract permits the company to be paid only if there are proven energy cost savings. Building measures implemented through an Energy Performance Contract usually involve the replacement of building equipment such as boilers and lighting systems. The combination of the DC Program and an Energy Performance Contract provides the best possible results for the School Board.

Partnerships

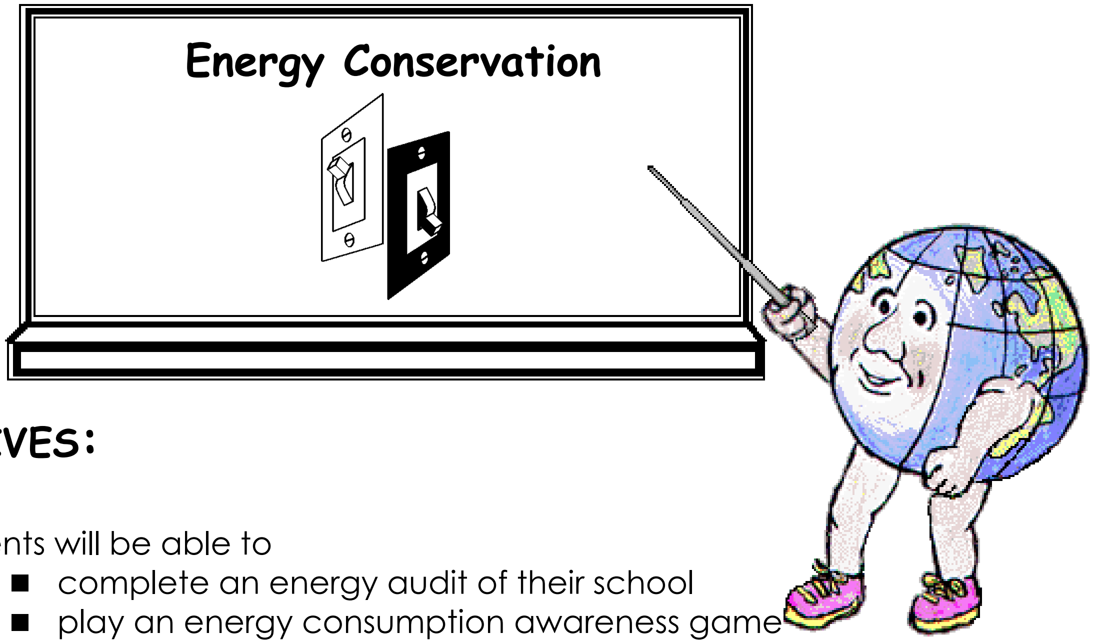
There are four groups of partners in the DC program. The School District Administration Team plays an integral role in coordinating the program. The DC Consulting Team consists of energy and education consultants. Corporate Partners agree to provide immediate start-up money as well as human resources for several years. The School Conservation Team conducts the technical audits and lifestyle campaigns. Team members include: the principal, teachers, students, parents, and the school maintenance staff.



Contact

Pacific Resource Conservation Society
& the Destination Conservation Program
148 East Second Street
North Vancouver, British Columbia
Canada V7L 1C3
T: 604.990.0165
F: 604.990.0166
toll-free 1.866.990.0165
E: info@dcplanet.ca

Energy : Lesson #4



OBJECTIVES:

Students will be able to

- complete an energy audit of their school
- play an energy consumption awareness game
- reflect upon their work in the form of a PMI Sheet (Plus/Minus/Interesting)

MATERIALS:

2 envelopes for each student (one marked "utility", one marked "me"), copy of Pay-Me Game Questions sheets, $200 of Energy Globey cash (two $5 sheets, one $10 sheet (found in previous lesson), and one $1/$20 sheet) per student, Copies of Destination Conservation's Energy Audits, 6 copies of PMI – Energy Audits sheet

PROCEDURE:

INTRODUCTION:

After playing an introductory game, students will conduct an energy audit of their schools and then design a media campaign for use in the school reminding others to conserve energy.

1. The Pay-Me Game

Students will play the Pay-Me game which is adapted from a game of the same name by The Alliance to Save Energy.

Each student receives 2 empty envelopes (one marked “Utility”, one marked “Me”) and $200 in Energy Globey cash ($20 in dollar coins, $60 in fives, $60 in tens, and $60 in twenties). Tell the students that they have been paid $200 in Energy Globey cash and that whatever money they and their family don’t spend on energy, they can use to buy the things they want. The teacher reads out the questions found on the attached question sheets and the students either pay themselves or the utility accordingly. If a student runs out of money before the end of the game, they may borrow from their “me” envelope to pay the utility.

Answer any student questions and do explanations over the course of playing the game.

When finished, the students are to add up the money in each envelope. They are not to count the money in their hand. Questions for teacher to ask:

Who has the most money in their “Me” envelope?
Who has the most money in their “Utility” envelope?
How could we get more money in our “Me” envelopes?

Tell the class that now that they have examined how much energy they use at home and some ways that they could use less, they’re going to do what’s called an energy audit of their own school to see how they could use energy more efficiently.

MAIN ACTIVITY:

The students are divided into groups of approximately 4 or 5. Each group receives a section of the Energy Audits acquired from the Technical Audits section of Destination Conservation’s Program Manual. There will be more than one group assigned to each Energy Audit but they are suggested to work as independent groups. Students follow the directions given on their audit sheets, recording the necessary information from their exploration of the school building and grounds.

When they have finished, all groups return to the classroom and share the scores that they have compiled for their section of the audit.

CONCLUSION:

1. Class discussion:

Each group will complete a PMI for their work today (student PMI sheet). The P (plus+) stands for something positive that they discovered, the M (minus-) stands for something negative and the I stands for something interesting or something that they wonder about. Each group should have a minimum of 2 students for each section.

2. Media Campaign

The students are now aware of the degree to which energy is wasted (or not wasted) in their school. The students will now produce a media campaign of posters and reminders to be used in the school to reduce energy consumption. The whole class brainstorms (using the brainstorming rules) ideas for what sort of reminders to make, slogans to include, and elements that will make the campaign good.

Brainstorm rules

1. Only one person speaks at a time.
2. Recorder takes notes.
3. Just ideas. Save discussion for after brainstorm is finished.
4. Some possible outcomes of the brainstorm:

SORT OF REMINDERS

- posters (for hallways, common areas, etc.)
- mini-posters (for doors, bathroom stalls, etc.)
- light-switch plates
- doorknob hangers

SLOGANS/REMINDERS

- Waste not, want not!
- Save your planet, one light switch at a time.
- Think energy conservation.
- Don't forget the lights!
- Did you turn off your lights?
- Did you turn off your computer?

ELEMENTS OF A GOOD CAMPAIGN

- no spelling mistakes
- catchy slogan
- eye-catching design
- neat and tidy work
- colourful

PAY-ME GAME QUESTIONS

Questions #1	YES	NO	Explanation
Do you have an electric blanket?	Pay Utility $3	Pay ME $3	Electric blankets cost about 12 cents a night or $3.55 a month. Using warm pyjamas and blankets save the most energy. But if your room is still too cold, it costs less to use an electric blanket than to heat up the whole room
Have your parents ever heated the kitchen with the stove or oven?	Pay Utility $15	Pay ME $15	If you ever see someone doing this, you should tell them that it is very dangerous and it does not work very well.
Do you have air conditioning in your entire house?	Pay Utility $65	Pay ME $30	A mid-size air conditioner costs about 25 cents an hour to operate. You can save money on air conditioning if you keep the windows and doors closed during the heat of the day. At night, you can turn off the air conditioner, open the doors and windows and turn on fans to get cool outdoor air into the house. Be sure to close the house back up before it gets warm again the next day.
Do you have a window air conditioner?	Pay Utility $30	Pay ME $30	Cooling only one room or area of your house costs much less than cooling the entire house. Keep doors closed to unused rooms.

Questions #2	YES	NO	Explanation
Do you take baths in the bathtub?	Pay Utility $8		A bath takes at least 68 L of hot water; that's at least 15 cents per bath. In a month that is about $4.50 per person.
Do you take showers that are 5 minutes long?	Pay ME $7		A shower that is less than 5 minutes will use less than 10 cents of hot water.
How many members of your family take showers than are more than 5 minutes long?	Pay Utility $7 for every person in your family who does this		
Do you always, always turn off the lights every time you leave the room?	Pay ME $7	Pay Utility $7	An average electric bill for lights alone is $14 per month.
Are your clothes dried in a clothes dryer?	Pay Utility $20	Pay ME $20	It costs about $1.18 per hour to operate. This can get very expensive after a few loads of laundry. Cleaning the filters after each load and drying one load right after another so the drum doesn't have to be re-heated for each load will save money.

Questions #3	YES	NO	Explanation
Do you sleep in a waterbed?	Pay Utility $20	Pay ME $20	Keep the temperature below 29°C and keep the mattress covered at all times to save money. There are special electric blankets that you can put on top of your waterbed which keep you warm without having to heat up all the water. These electric blankets can save a lot of money.
In the summer, are the curtains or blinds in your home closed to keep out the heat?	Pay ME $15	Pay Utility $7	Closing curtains and putting up shades keeps the sun and warm air from getting into your house, which keeps your house cooler. Students will probably be familiar with how light coming through a car window can heat up a car on a hot day. A house with direct sunlight coming in heats up the same way.
Do you use a dishwasher to wash your dishes?	Pay Utility $7	Pay ME $5	If you turn the drying cycle off and open the door to let the dishes dry, pay ME $3
Do you have more than one refrigerator or freezer at your house?	Pay Utility $16 for each extra		Each extra fridge or freezer costs about 4$ per month, or nearly $50 per year!

Questions #4	YES	NO	Explanation
Is your refrigerator opened more than 6 times per day?	Pay Utility $3 for each person that opens the door	Pay ME $7	It costs about 4 cents each time the door is opened.
Do you use a hairdryer?	Pay Utility $5	Pay ME $5	It costs about 12 cents every time you use a hairdryer.
Do you listen to the radio or use a DVD Player?	Pay Utility $3	Pay ME $2	It costs the average household about $3.40 a month to use these.
Do you play video games?	Pay Utility $ 6	Pay ME $3	Even though most video games are electronic and use a small amount of electricity, they are often played for many hours.
Do you have an electric toothbrush?	Pay Utility $2		These tootbrushes require electricity to charge their batteries so you can brush your teeth.
Do you have a swimming pool?	Pay Utility $30		Pools are expensive to operate, especially if you heat them. The pool filter alone costs 15 cents per month.
Do you have an electric clock?	Pay Utility $2	Pay ME $2	A wind-up clock does not use electricity.

Questions #5	YES	NO	Explanation
Do you have an electric can opener?	Pay Utility $2	Pay ME $2	Hand operated openers work well for most people.
Do you use a portable electric heater in winter?	Pay Utility $30	Pay ME $15	In general, portable heaters are one of the least efficient heating sources. If you're the only one who's cold, consider putting on an extra pair of socks or a sweater.
Does your freezer have an icemaker?	Pay Utility $5		It is cheaper to make ice cubes with ice cube trays.

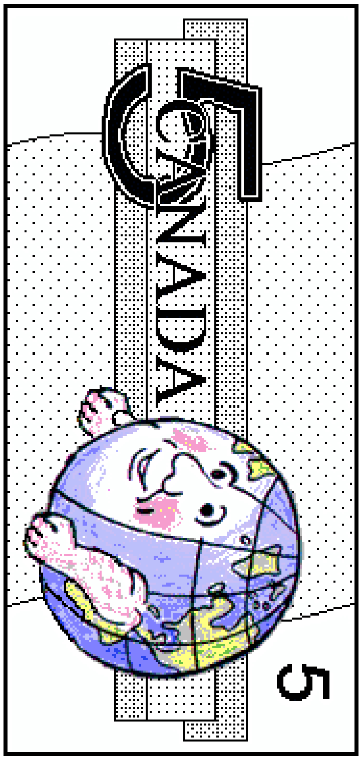
PMI - ENERGY AUDITS

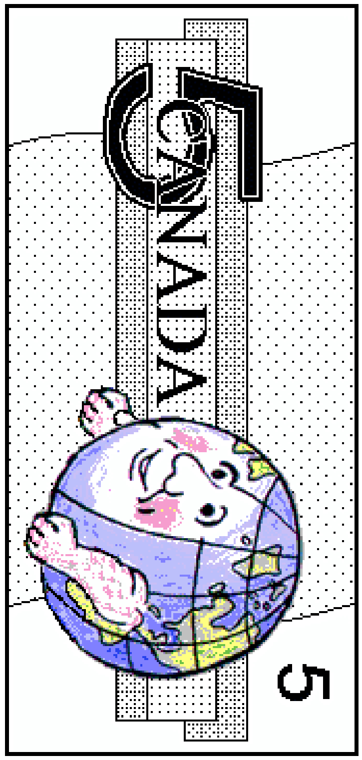
Energy Audit #: _____
Group Members: ______________________
____
____
____
____

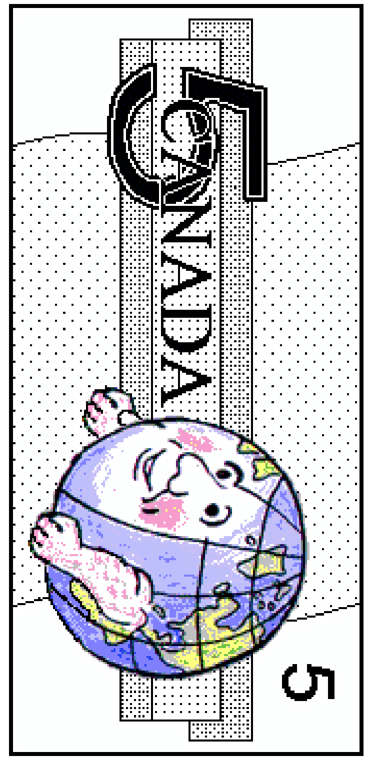
Plus (+)	• •
Minus (-)	• •
Interesting (?)	• •

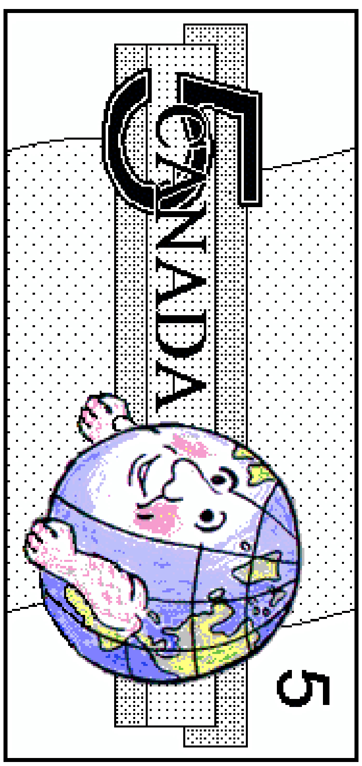
One thing we would do better or change if we did this activity again

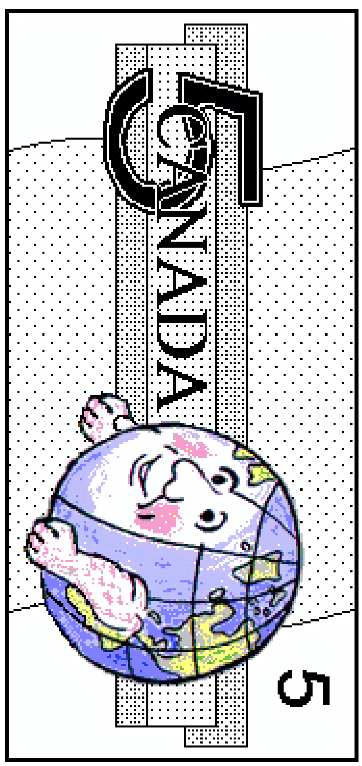
____
____
____
____

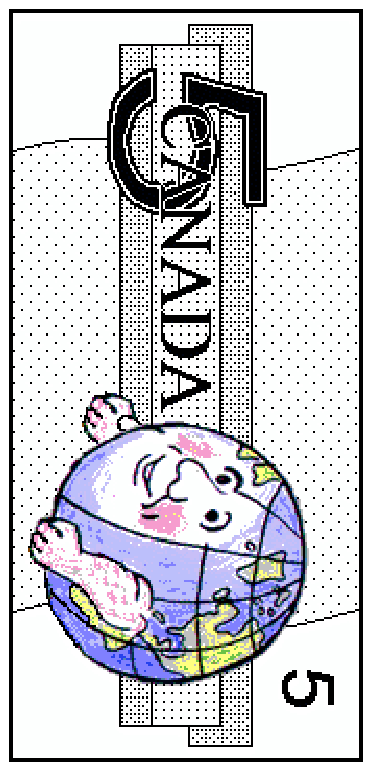

CANADA
5
5


CANADA
5
5

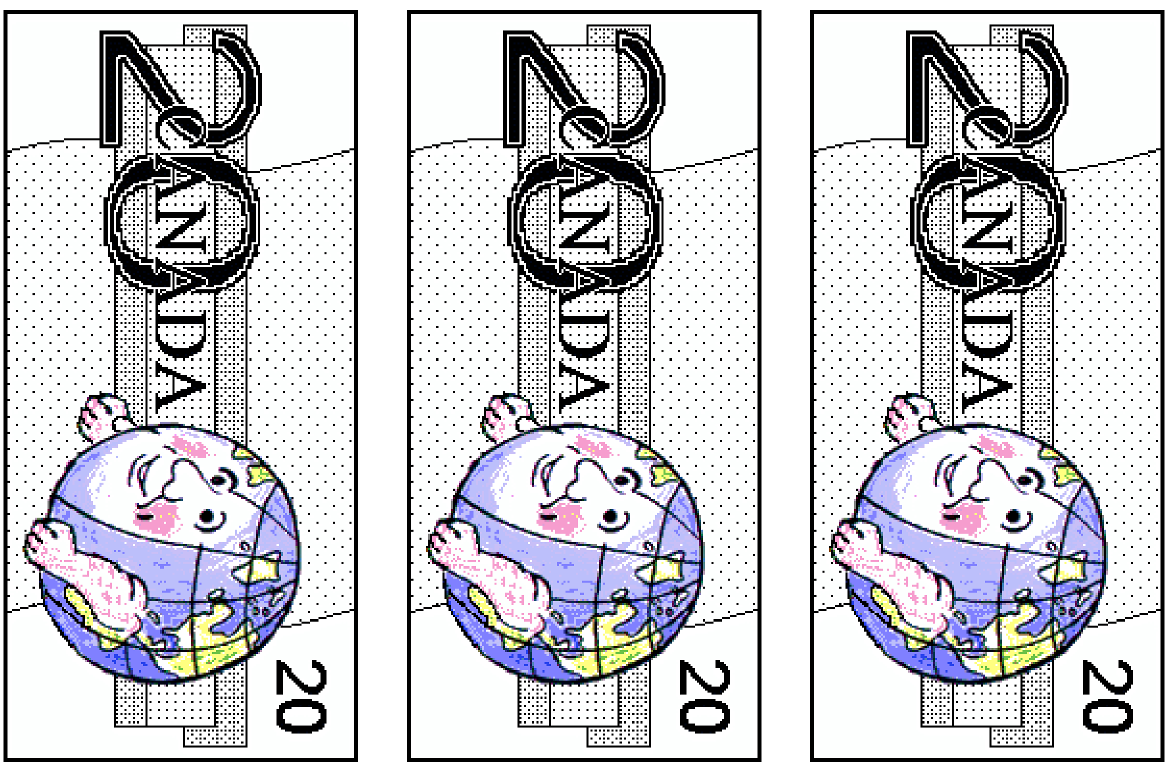

CANADA
5
5


CANADA
5
5


CANADA
5
5


CANADA
5
5


GLOBEY DOLLAR


20
CANADA
20

Energy Audit #1

HEATING, VENTILATING AND AIR CONDITIONING

Most of the energy your school consumes is used for heating the building. The furnace is one of the biggest users of energy in your school. Furnaces use a heat source (*natural gas*, *oil* or *electricity*) to heat air or water. The heated air or water is then pumped to every room in the school. In most rooms, a *thermostat* controls the room's temperature.

In the summertime, *air conditioning* is sometimes needed to cool the school. In some places in Canada, schools only need air conditioning for a few days or weeks every year. In other places, however, the air conditioning is used so much that cooling the school uses as much energy as heating the school!

There are many things that can be done to improve the efficiency of the heating and cooling systems.

SCORING

The total possible score in this section is 17. When you have finished answering the questions, add up the total number of points you have circled and enter this score in the space below and in the chart on page 2-15.

Total number of points	Total score
17	

Energy Audit #1/pg.2

Heat energy

Circle the Yes or No icon as you answer each of the following questions. The point value of each answer is noted inside the icon.

Yes	No	
		1. To heat your school building, does the school use:
1	0	a) *solar energy?*
1	0	b) natural gas?
0	1	c) electricity?
0	1	d) oil?
1	0	2. Does your school use *automatic setback thermostats* to reduce room temperatures when the building is not occupied?
1	0	3. Does your school use a *computer-controlled system* for setting thermostats?
		4. Does your school keep the thermostat(s) set at the following temperatures during the day:
1	0	a) 20°C or lower for classrooms?
1	0	b) 18°C or lower for gymnasiums and corridors?
1	0	c) 15°C or lower for vestibules?
1	0	5. Does your school turn off the heating system's *pilot light* during the summer holidays?
1	0	6. Does your school have *coniferous trees* on the north and west sides to block cold winter winds?
0	1	7. Are electrical *space heaters* used anywhere in the school? If so, list the locations where they are found.

Energy Audit #1/pg.3

Cooling energy

Circle the Yes or No icon as you answer each of the following questions. The point value of each answer is noted inside the icon.

Yes	No	
1	0	1. Has your school installed *window awnings* to provide shade for windows on the south side of the school?
1	0	2. Does your school have *deciduous trees* for shading and natural cooling on the south side of the building?

If your school has air conditioning, answer the remaining questions. If your school doesn't have air conditioning, add three points to your total.

Yes	No	
		1. Is the air conditioning thermostat set at moderate temperatures:
1	0	a) 22 degrees Celsius (°C) or higher in the daytime
1	0	b) 26°C or higher at night?
1	0	4. Is your school's air conditioning system shut off during evenings and on weekends when it is unoccupied?

Energy Audit #2

DRAFT-PROOFING

Once the school's furnace produces heat to warm the inside of the school, cold air entering the building through open doors and cracks forces the warm air outside. Most heat escapes through open doors and through cracks around doors and windows. Just by repairing old or damaged *weather-stripping* and replacing *caulking*, the school's heating bill can be greatly reduced.

For this audit, every member of your group will need a *draft detector*. One way to make a draft detector is to glue a feather onto the end of a toothpick and put the other end into a piece of plasticine. Another way is to tape a piece of toilet tissue or facial tissue to a pencil, so 10 cm of tissue hangs off of the pencil. By holding the draft detector beside doors and windows you can see if drafts are entering the school. When using your draft detector, be careful not to be misled by drafts from nearby heating vents or air currents caused by students moving.

SCORING

The scoring in this section depends on the number of windows and entrance doors in the school. Enter the total number of doors or windows and the total number that are *air-tight*, on the charts on the following pages. Using the table at the bottom of each chart page, calculate the score for that area. Enter the total score for this audit on the chart below and in the chart on page 2-15. The total score for this section is six.

Total number of points	Total score
6	

Energy Audit #2/pg.2

Entrance doors

With your group members, go around the school and check every entrance door with the draft detector. (Don't forget the emergency exits from gymnasiums and auditoriums.) Circle the icon to note if each set of doors is air-tight or not. When you are finished, add up the total number of doors and the number that are air-tight (total number of Yes answers). Using the chart at the bottom of the page, convert the proportion of air-tight doors to a score out of three.

Entrance door location	Are the doors air-tight (no air is leaking in around the doors)? Yes	No
	1	0
	1	0
	1	0
	1	0
	1	0
	1	0
	1	0
	1	0
Total number of doors:	Total:	

Proportion of air-tight doors	Score
0 to 1/4	0
1/4 to 1/2	1
1/2 to 3/4	2
3/4 to all	3

Energy Audit #2/pg.3

Windows

Using the draft detectors from the previous question, check the windows in five rooms in your school. Try to check some classrooms, along with some other areas such as lunch rooms or school offices. Note the room location, the total number of windows, and the location of any *drafty* windows you find. Add up the total number of windows and the number that are air-tight. Using the chart at the bottom of the page, convert the proportion of air-tight windows to a score out of three.

Room number or description	Number of windows	Location of drafty windows	Number of drafty windows	Number of air-tight windows
Total number of windows:		Total number of air-tight windows:		

Proportion of air-tight doors	Score
0 to 1/4	0
1/4 to 1/2	1
1/2 to 3/4	2
3/4 to all	3

Energy Audit #3

LIGHTING

Lighting uses more electricity than anything else in your school. Using inefficient lights, or having too many lights installed, wastes electricity. It is often most cost effective to install more *energy efficient lights.*

SCORING

The total possible score in this section is 11. When you have finished answering the questions, add up the total number of points you have circled and enter this score in the space below and in the chart on page 2-15.

Total number of points	Total score
11	

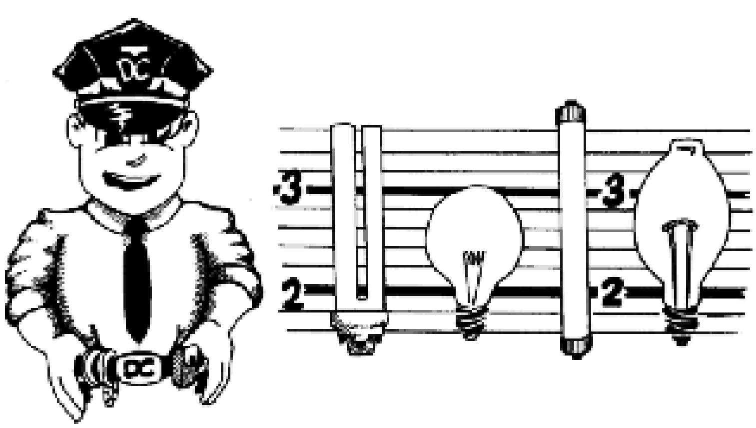
Energy Audit #3/pg.2

Circle the Yes or No icon as you answer each of the following questions. The point value of each answer is noted inside the icon.

Yes	No	
		1. Does your school have energy efficient lights in the:
1	0	a) gymnasium(s)?
1	0	b) hallways?
1	0	c) classrooms?
1	0	d) washrooms?
1	0	e) school office(s)?
1	0	f) school auditorium?
1	0	g) staff room(s)?
1	0	h) shower/locker rooms?
1	0	2. Has your school *de-lamped* four-lamp fixtures by removing two lamps? List areas where de-lamping has taken place.

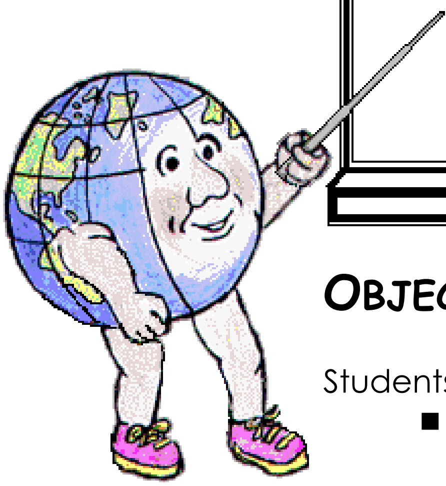
____
____
____
____
____
____

Yes	No	
1	0	3. Does your school use *photocell controls* for outside security lights? These lights turn on automatically when darkness falls.
1	0	4. Does your school use *occupancy sensors* to turn lights on only when someone is in a room?



Energy : Lesson #5

History's Energy Lesson For the Future



OBJECTIVES:

Students will be able to
- read a story about a pioneer child's typical day
- complete a Venn diagram comparing their life with the day described in the story
- write a journal style story that describes what their life might be like without electricity
- make a knowledge chain to show what they have learned

MATERIALS:

Copies of "A Day in the Life" story, copies of Venn diagram (one per student or per pair), strips of brightly coloured paper (4cm wide and 40 cm long)

PROCEDURE:

DESCRIPTION:

Students will read a fictional story about the life of a pioneer child and compare and contrast this with their lives in terms of the effect of electricity on our lives.

INTRODUCTION:

Brainstorm

Students are to brainstorm difficulties that arise when there is a power failure. Before beginning, review the following rules for brainstorming and give students a minute to think about possible answers. Record the answers on a web graphic organizer either drawn on chart paper or on the board.

Brainstorm rules
1. Only one person speaks at a time.
2. Recorder takes notes.
3. Just ideas. Save discussion for after brainstorm.

"Now that we've thought about what it would be like not to have power temporarily, let's think about what it would be like not to have power ever.

Can anyone think of when that might occur? (before the invention of electricity, before where you live had electricity, when you're camping, etc.)

Today we're going to read a story about what day to day life was like in Nova Scotia before there was electricity"

MAIN ACTIVITY:

Read the accompanying fictional story " A Day in the Life of a Pioneer Child. Students may like to read aloud in partners or read silently.

Discuss the story with the students.

- Are there things that surprised you?
- Is this different from how we do things?
- How is if different?
- Do you think their life was easier or harder than ours is?

Have students complete a Venn diagram, which compares and contrasts our daily life with the daily life of a pioneer.

Some hints for using the Venn diagram:

- One circle represents the life of the pioneer child and the other our life. The overlap area represents the common areas that the two share.
- For the separate sections of the circles ask "how are they different?" and for the overlap area ask, "how are they the same?"
- It may be helpful to do a sample Venn diagram with the class before having them do their own. Example: Compare and contrast 1) television and movies or 2) Musical groups

Some hints for using the Venn diagram:

- One circle represents the life of the pioneer and the other is our life. The overlap area represents the common areas that the two share.
- For the separate sections of the circles ask "how are they different?" and for the overlap area ask, "how are they the same?"
- It may be helpful to do a sample Venn diagram with the class before having them do their own. Example: Compare and contrast 1) television and movies or 2) Musical groups (ex. Backstreet Boys and N Sync)

CONCLUSION:

1. Knowledge chain:

Each student must think of at least one interesting thing they learned during this lesson and write it on a slip of paper. Students will then attach their slips of paper to each other's to make a paper chain. Students can add to their knowledge chain over the course of the unit or the day. Teachers can use the knowledge chain to see what students are getting out of the lesson.
*Different bright colours of paper make for an interesting knowledge chain!

2. Journal

Have students write a journal entry that talks about what it would be like not to have electricity. Here are some ideas to get them started:
- you are a Black Pioneer, Acadian, other type of pioneer, or First Nations individual living at least 100 years ago
- pretend you are growing up in your grandparents' time
- you are living through a large-scale power outage (ice storm?)
- any other situation where you wouldn't have the use of electricity

Suggest to students that they use their Venn diagram to help them with ideas or remind them of some of the restrictions of not having electricity.

Optional

If the journal idea is not appealing, you could have the students make comparisons between a common daily activity now and then. Examples: getting to school, washing clothes, making supper.

Have them compare and contrast

- the amount of time needed to complete the task
- the equipment needed
- the skill needed
- the impact upon the environment

A DAY IN THE LIFE OF A PIONEER CHILD

Circa 1812

The day starts in the coolness of my bedroom, the one I share with my sister. It is hard to get out from under our warm blanket. It's chilly up here in the morning, even though it's April.

We're always plenty warm once we get up, since Mama has the fire going for at least an hour before she calls us to do our morning chores. There are things to be done before we go to school. We milk the cows and feedthe pigs and chickens. We have to take care of the animals so that we will have food to eat and to sell. Today we collect eggs for breakfast and some days we collect them to be sold at market while we're at school.

After breakfast, we walk the mile to school. The horse is for Papa's work, not for taking us to school. It's a chilly morning and thankfully our teacher has arrived early this morning to put on the fire in the schoolhouse. Some mornings we keep our capes and mittens on because it's just too cold without them. My older sister is lucky because she gets to sit in the back of the room, closer to the stove. Since I'm small, I sit up front and sometimes the heat doesn't reach my friends and me right away.

For the first part of the day, we go over the passages from the New Testament that we learned yesterday. Sometimes it's hard to remember from one day to the next, but I do my best. I like the times when we read from the Bible better than just reciting. My favourite time is when we get to write and spell on our slates, though sometimes I make foolish mistakes.

In the afternoon, the other girls and myself work on sewing. My sister Anna is better than I am at sewing, since she's been doing it longer. I hope that one day I can sew as well as my Mama so I can make all the things for my family that she makes for us. She makes all our clothes. They're not as fancy as some of the store bought clothes, but they are warm and last a long time.

My brother doesn't go to school anymore. Papa needs him to help with the farm. A lot of times Anna and I stay on the farm too, when there's a lot of work to be done. Some of the children in my class only come to school a couple of days a year because they're needed at home.

While we were at school, Papa and James plowed part of the field and got it ready to be planted for this year. We don't have a lot of land and it isn't very good, so we are lucky if we grow enough to support us and have extra to sell. Still, we are thankful for what we have compared to many of the families in our community. This year Papa is going to plant turnips, beans, carrots, onions, potatoes, lettuce, and pumpkins.

Papa and James also cleaned the well today. It's a big job. James climbed down a long ladder and bailed out the well with buckets that he passed to Papa. Then he gathered up all the sticks that had collected and scrubbed the algae off the stones. Once the water level comes back up, Papa will catch a new trout to put in the well. The trout will eat the bugs that get in the well and will also let us know if the well water is clean. If the trout gets sick and dies, then we know there's something wrong with the water.

Today was wash day. Mama heats the water on the stove and then dumps it into the wash basin. Then she scrubs the clothes with a washboard. It's a lot of work. Once the clothes are all scrubbed, Mama hangs them on the line to dry. Sometimes it takes a couple of days for the clothes to dry, so Mama tries to do wash on sunny and windy days.

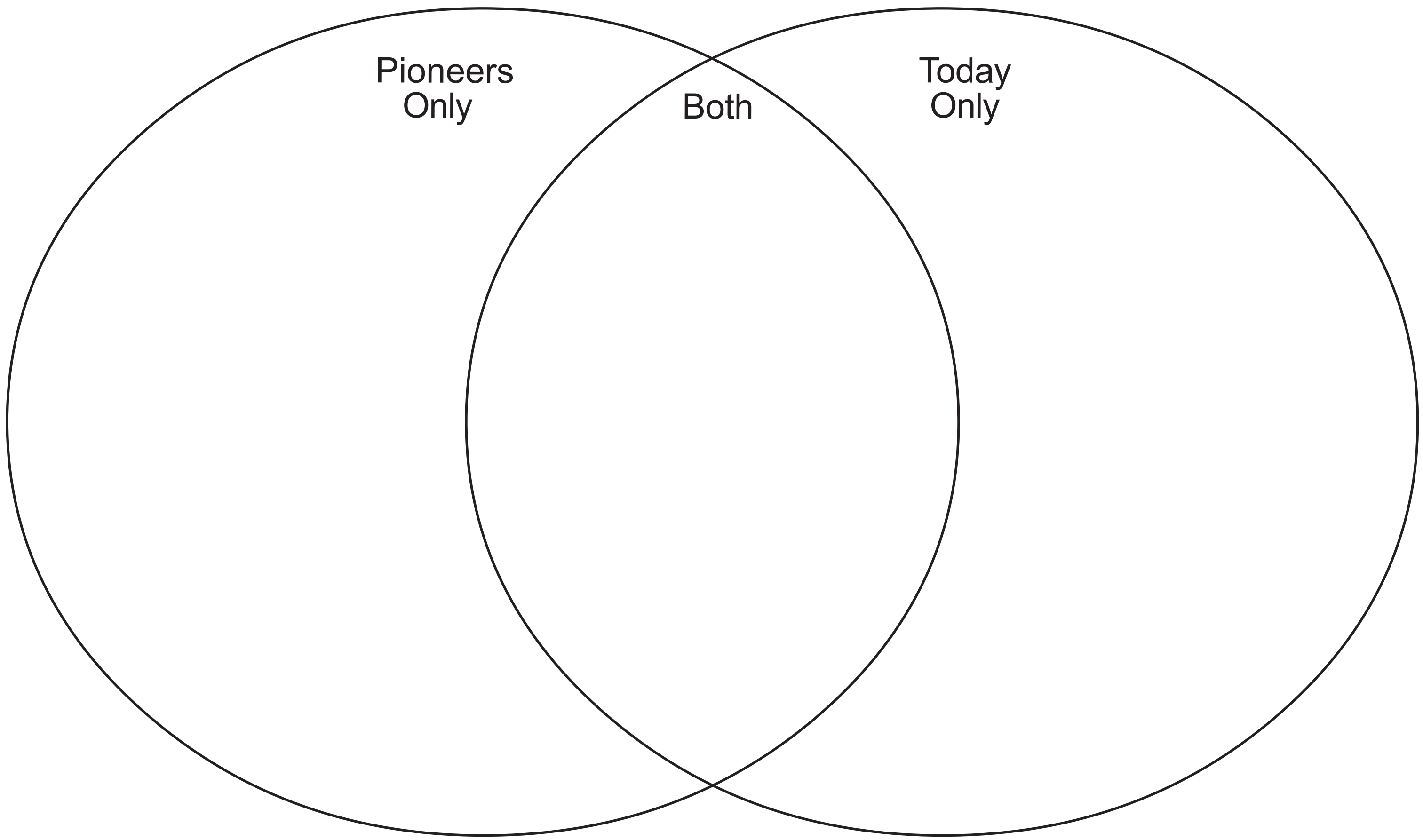
In the fall, Papa and James go out hunting in the daytime to get meat to last us through the winter. Sometimes they get a deer or moose, but a lot of times they get small animals like rabbits or pheasants. When they get a big animal, Mama helps to cut and salt it, then its put in big barrels to keep it for the winter.

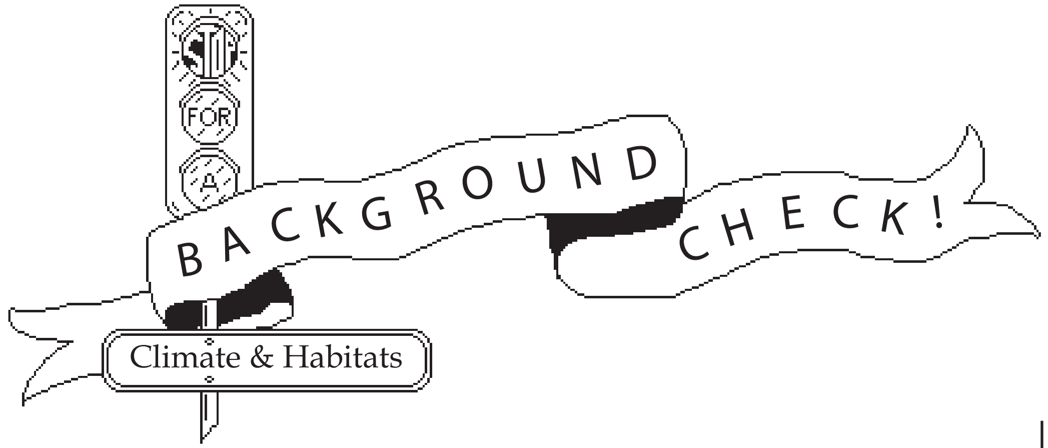
After school, Anna and I go to the barn to do more chores. The cows have to be milked again and the stalls need to be cleaned. Papa and James work on the big jobs during the day and leave the daily chores to us for the morning and afternoon.

For supper we have fresh bread and baked beans. Mama makes the bread herself. After supper, we're all tired from a long day. Papa has Anna and I read from the Bible for a little while. It's much easier to read at school in the light of day instead of by kerosene lamp, but we read anyway. While we read, Mama works on her braided rug. She makes them from pieces of old clothing so that nothing is wasted.

Soon it will be bedtime. We say our prayers together. Then Mama will bank the fire for the night and Papa will put out the kerosene lamp. We get ready for bed in the dark and snuggle in to our beds for a good night's sleep.

Venn Diagram
Compare and Contrast





When we look at a biological community, we find important interrelationships and interdependencies between plants and plants, plants and animals, and animals and animals. The environment in which an animal lives is called its "habitat".

An animal's habitat includes food, water, shelter and space in an arrangement appropriate to the animal's needs. If any of these components of habitat are missing, or are affected significantly so that the arrangement for the individual animal or population of animals is no longer suitable, there will be an impact. Disease, predation, pollution, accidents and climatic conditions are among other limiting factors which can affect an animal's ability to meet its needs.

This section will look further into the impact of Climate Change on habitats, and in particular at the impacts that could result from the warming of global temperatures. It is predicted that a temperature rise would increase severe weather, throw off migration routes, alter the geographical locations suitable for habitats for various animals, and increase the level of water in the oceans. The impacts of these changes could range from minor to catastrophic, and have the potential to affect plants, animals and humans around the globe.

Key Words

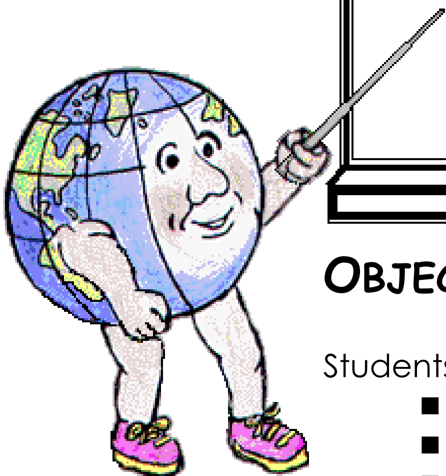
Habitat, Food, Water, Shelter, Space,

Sources

WILD Education
Canadian Wildlife Federation
Tel.: 1-800-563-WILD (9453)
Fax: (613) 599-4428
E-mail: info@cwf-fcf.org
Web Site: www.wildeducation.org

Habitat : Lesson #1

What in the World Is a Habitat?



OBJECTIVES:

Students will be able to

- describe how people affect the habitat of wildlife
- describe the important aspects of a habitat
- make connections between their own habitat and others
- make suggestions of how we can share habitats with other creatures
- link specific behaviours of animals to how they live in a given area

MATERIALS:

- Tree costume
  (old hat with paper leaves glued to it, apron painted brown for trunk, roots and branches made from construction paper, extra real leaves and branches to be held in hand),
- shrub costume
  (fake nuts and berries attached to an apron painted green),
- cut out or drawn and coloured pictures of
  forest animals (Great Horned Owl, squirrel, rabbit, small bird snake, mouse)
  stream animals (fish, turtle, beaver, raccoon, frog, insects
- long blue material as stream, 5 metres of string, graph paper, marker, camera with film, measuring stick, coloured paper cut out in shapes of hills, waves, leaves, and berries.

PROCEDURE:

INTRODUCTION:

This activity was adapted from a lesson plan created by the Dallas zoo. It is a wonderful introduction to what a habitat is and how everything is interconnected. Ask for definitions from the class as to what a habitat is. Write the suggestions on a graph paper so that they can be referred to later if you want to eventually compare them to a possibly more accurate definition. Try and get them to include in their definition, what the key aspects of habitats are. Continue working with their suggestions until habitat is defined as a *region where a plant or animal naturally grows or lives. The important components are food, shelter, water, and space*. Write each component on a separate sheet of chart paper and then have the class describe the importance of each component by using human beings as an example. Write each example under the proper component, on the top half of the chart paper.

MAIN: BUILD HABITAT

Hold up the picture of the Great Horned Owl for the class. Ask for a show of hands as to who knows what type of owl it is. The one that answers correctly, or comes closest, gets to hold the picture and stand at the front of the classroom. Inform the class that they will be making a habitat for the owl. This can be adapted if a different type of animal is presently being favoured in some form of a theme unit.

Ask the class what habitat component would our homes fit under. Point to the "shelter" component sheet and ask what type of a shelter an owl has in its habitat. The student that answers correctly is given the tree hat. Write, "tree" on the bottom half of the "shelter" chart paper. Ask the class to help come up with as many advantages the tree would give an owl (like hiding from predators, protection from the weather, a lookout for finding prey, and a sturdy home). Fill the rest of the chart paper with the suggestions. Have the student who has the tree hat come up to the front of the room. While reviewing the different parts of trees by asking the class what they are, assemble the rest of the tree costume on the student.

Ask the class what habitat component, for us, would a sandwich or salad fit under. Point to the "food" component sheet and ask what type of food an owl eats. Write down the answers given on the bottom half of the "food" chart paper and if any of the creatures mentioned have a picture to go along with them, hand it out to the student that mentioned it while having them come up to the front of the class. If someone mentions berries or shrubs, have them put on the shrub costume and also stand in the front of the class. Once the mouse, squirrel, rabbit, insects, small bird, snake, and shrub are assigned, take suggestions of how they are interconnected. For example, the mouse, rabbit, squirrel, insects, and small bird get their food from the tree and shrubs, the frog gets food by eating insects, and the snake gets food by eating the mouse.

Ask the class what habitat component represents things we drink. Point to the “water” chart paper and fill the bottom with ways the owl might get water. Assign two of the students who answered and have not yet been assigned a role, to be the stream. Have one on each end of the blue material at the front of the class and give the material a small wave while holding it to represent a flowing stream. Have the rest of the students who are already at the front of the class position themselves around the stream in a way that they believe a real habitat would be organized.

Take suggestions from the students still sitting as to what other creatures would share a habitat with a stream. Have students represent the fish, beaver, turtle, and raccoon and position themselves in the stream area of the habitat.

Ask the class what habitat component has not yet been dealt with. Point to the “space” chart paper and inform the class that the roots of a tree grow 4 times the height of the tree itself. Write this formula on the bottom half of the “space” chart paper. Measure the height of the student that is acting as the tree, write it on the chart paper, and then ask the class to figure out, in their heads, how long the roots would be. Cut the string to the proper length and then have the tree student hold one end and rotate on the spot while you walk around holding the other end in order to demonstrate how much of an area would be needed for the roots.

Have the students at the front of the class pose for a perfect habitat picture. Make sure all of them are holding up their pictures and are in their proper positions.

Destroy Habitat

Have the remaining students pretend to be from a lumber company that has decided to cut down the tree to make a house for people to live in. Take a picture of the lumber company students removing the trunk, branches, roots, and top of tree.

Do the following steps one by one.

- The tree student sits back down in the seats with the lumber company.
- Have the owl and squirrel sit back down because they lost their shelter in the tree and must try and find somewhere else to live.
- The stream students sit down because the stream dried up from the heat of direct sunlight now that the tree’s shade has gone.
- The fish, turtle, and frog die because they have no water and the raccoon and beaver must leave to search for more water.
- The shrub withers as well from the heat and lack of water so the rabbit and bird must leave to find new shelter and food.
- The only ones left are the mouse, snake, and bugs but since people find them to be pests, they are exterminated.

CONCLUSION:

Go back to the different components of habitat and ask for suggestions from the class as to how we can still sustain our habitat component without destroying or removing another creature's habitat component. Divide the class into the four component groups and have each student come up with a different suggestion for their component. Have them write these on coloured paper cut out in the shapes of leaves (shelter), berries (food), hills (space), and waves (water). Assemble the finished suggestions, along with the pictures and photographs, on a bulletin board labeled "What in the World is a Habitat?"

Additional Activities

Mathematics:

- Have each student calculate out the area of land needed for the tree to spread out its roots if the tree were as tall as they are.

Language Arts:

- Incorporate the lesson into the novel "Owls in the Family" by Canadian author Farley Mowat. Have the class find aspects from the novel that show Wol's different components of habitat when living in the city and compare it to the habitat of the wild owl at the start of the story.

Geography:

- Look at different types of owls found around Canada and see how their habitats differ along with their map location.

Background Check!

Where Are Habitats?

Home Is Where You Habitat

Children often picture natural habitats as existing far away from their own surroundings. For example, children often list habitats as jungles, forests, riverbeds, or ocean floors. An important realization is that our school and home environments represent our own habitat as well as the habitat for countless numbers of different animals and plants. The following lesson makes this connection by having the students identify different aspects of their own habitat and which plants and animals they share it with.

The effect of climate change on different habitats is presently being studied in Nova Scotia. One such study is the "Thousand Eyes" project coordinated by the Nova Scotia Museum of Natural History. Like the following lesson, it involves the help of students around the province by having them submit specific information about the habitat with which they live. Please read on to find out what it is about and how to become an important part of the project.

The MacKay Experience : The Thousand Eyes Project

Project Description:

Dr. A. H. MacKay was the Superintendent of Nova Scotia Schools more than one hundred years ago. While in this position MacKay had 1,500 schools from around the province participate in collecting data concerning different habitats and regions in Nova Scotia. One hundred years later the Thousand Eyes project is asking schools, individuals, and community groups to repeat many of those observations. By comparing the results and the historic MacKay results they will look for evidence of climate change. Plants and animals integrate the effects of climate change factors over time. They are sensitive indicators of heat precipitation, wind, photo period, and humidity. These factors coupled with historic and present day weather data should be able to give scientists a sense of climate change and weather trends over the last 100 years.

The historic MacKay records spanning 24 years have been digitized and information from them is available on the Web (www.thousandeyes.ca) through a cooperative project led by the Nova Scotia Museum of Natural History, the Climate Change Action Fund, and the Ecological Monitoring and Assessment Network. Students involved in this project report their results directly via the Internet on the project's website, www.thousandeyes.ca. This data will then be transferred directly onto digital maps in real time.

Key Words

Habitat,
Climate Change,
"Thousand Eyes",
N.S. Musuem of Natural History,
MacKay Records

This project resurrects a climate change network initiated at the turn of the 20th century. Having schools and communities track these seasonal events will promote a greater understanding of the regional effects of climate change. The MacKay data has set a benchmark. By collecting these observations 100 years later we will have an effective tool to understand and measure climate change.

Some of the Project Goals:

-To have participants from each county in the province as Nova Scotia is made up of many distinct eco regions due to geography and maritime climates.
-To prompt individuals into active outdoor participation as climate change and its effects will be better understood and have more impact on people's daily lives if they are involved in doing rather than just reading.
-To identify plant and animal life cycle events that integrate the various effects of climate change. These species can then be used to detect climate change factors in continuing provincial and national studies.
-To track the timing of naturally occurring events in order to identify the effects that human activity has on regional biota.
-To initiate and sustain "community based data collection" and a reporting network that will produce data that is both accurate and useful in the measurement of climate trends.

Teacher Training Strategies:

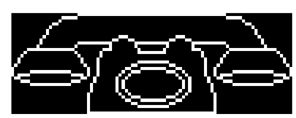
Colourful classroom posters (spring, summer, and fall) showing the identification of the observations are distributed to participating schools. Field guides, which detail the 50 phenomena we are interested in tracking, are also distributed to each participating student. Additional resource information is available on our Internet site, www.thousandeyes.ca.

The reporting of the data is done by the students directly over the Internet. This is a self-contained pre-packaged activity which satisfies components of the curriculum and brings awareness to the classroom.

Invitation to Teachers:

Is the winter really getting milder? Is the summer getting hotter and drier and did the dandelions and robins come out earlier than usual in the spring? You can participate in a project that will find the answers.

100 years ago students across Nova Scotia recorded natural change events, phenology. We want you to continue this job so we can look for evidence of climate change. If you would like to record events ranging from the first blooms of spring wild flowers to annual bird migrations, report them directly over the Internet, and then watch your events be digitally mapped on our Website, contact us. This program is suitable for elementary, junior high and senior high students. To register for participation, curriculum resources and project materials, see the contact information.

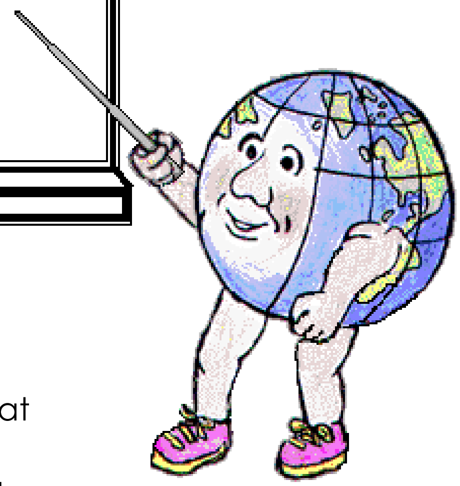


Contacts

Thousand Eyes
Project Coordinator
Christopher Majka
Tel: (902) 424-6435
Fax: (902) 424-0560
info@thousandeyes.ca

Nova Scotia Museum
of Natural History
(902) 424-7353
Visitor & Event Info
(recording)
(902) 424-6099

Habitat : Lesson #2



OBJECTIVES:

Students will be able to

- identify different aspects of the habitat around them
- record observations and gather data
- depict how their environment affects their lives

MATERIALS:

Deck of cards, home habitat activity sheets, chart paper, and 4 markers

PROCEDURE:

INTRODUCTION ACTIVITY:

This activity is best begun on a Monday so that the students have all week to complete the take home section. Have four pieces of chart paper set up around the room with a marker at each station. Each one has a different suit at the top of the paper (♣ ♦ ♥ ♠), followed by one of the following titles: Sounds, Plants, Animals, and Minerals. Only use as many cards as you have students while keeping an equal number in each suit and starting with the ace as a one, then the two and so on. For example, with a class of 25, there could be the following cards used: ♣A234567, ♦A23456, ♥A23456, and ♠A23456. Shuffle the cards and deal one to each student. They are to move to the chart paper which has the same suit displayed as they have been dealt and line up numerically with the Ace in front and the highest card at the back.

Now that they are all in position, inform them that they each have to come up with something they believe can be found in the school yard that fits under their category. Each student at the front of each line writes one thing from the schoolyard on the chart paper that fits their category and then prints their name beside it. The markers are then passed to the next students in line. When students finish, they pick up a Home Habitat activity sheet that corresponds to their category and then return to their seats. The next student to receive a marker must put something on the chart paper that is not already there. The printing of the names is to ensure that you have a list of who is in each category.

MAIN ACTIVITY:

As a class, go over each different category and try and come up with something new for each. Inform the class that the sheets they had collected are to be done for homework during the week. They are to come up with four different aspects of their home environment that fit their category and fill out the sheet appropriately. Assign one aspect (a row) for each night of homework and check to make sure they are completed the next day. Each aspect is to be accompanied by a drawing, diagram, or sample (only if it will not endanger the natural habitat if it is removed).

CONCLUSION:

Have each student write about one of the things they had on their Home Habitat sheet. They should explain one way that it is affected by their lives. Also have them write how they believe that aspect of the habitat affects their life, and what would happen if it were taken away.

Sound Scavenger Hunt

Name : ____________________

Date : __________

Date	What sound did you hear?	What made the sound?	How loud was it?	Where did you hear it?	Describe something else about the sound.

Plant Scavenger Hunt

Name : ____________________

Date : __________

Date	What type of plant did you find?	How tall was the plant?	What colours did it have?	Where did you find it?	How was it's structure adapted to the area?	Describe something else about the plant.

Animal Scavenger Hunt

Name : ____________________

Date : __________

Date	What animal did you see?	How big was the animal?	What colour was it?	Where did you see it?	Describe something else about the animal.

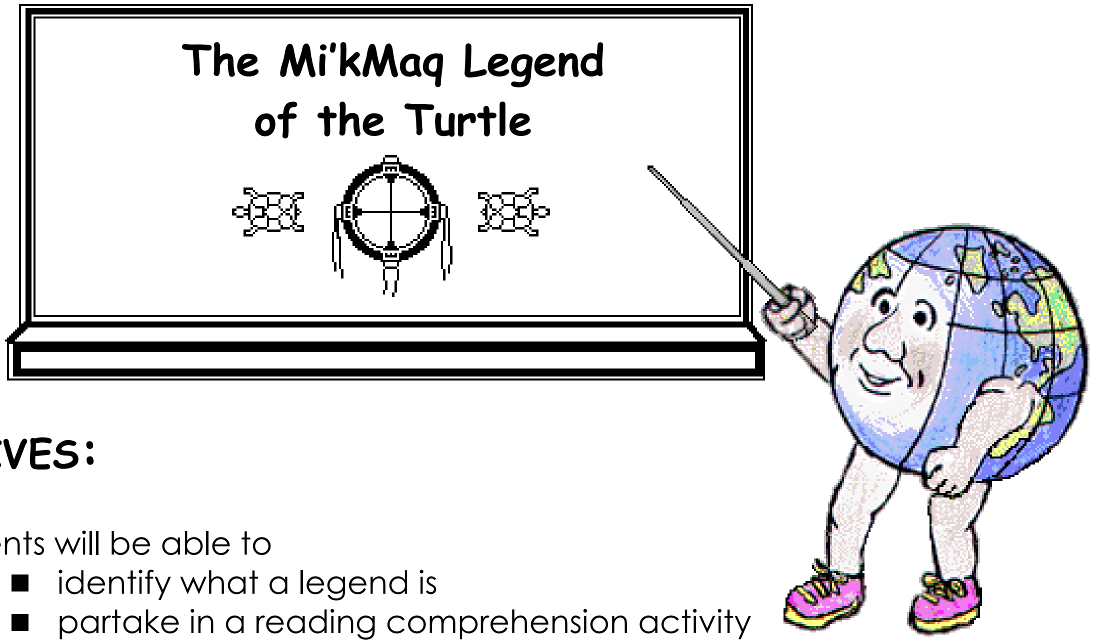
Mineral Scavenger Hunt

Name : ____________________

Date : ____________

Date	What type of mineral do you believe you found?	How big of an area did it cover?	What did it feel like?	Where did you see it?	Describe something else about the mineral.

Habitat : Lesson #3



OBJECTIVES:

Students will be able to

- identify what a legend is
- partake in a reading comprehension activity
- write their own imaginary legend or myth
- explain how climate affects habitat

MATERIALS:

Class set of handout sheets with Turtle Legend, questions, and suggested topics on them

PROCEDURE:

INTRODUCTION:

Brainstorm with the class on the chalkboard as to what a legend is. Try to keep the definition concerning traditional stories or myths. Ask the class if they know of any legends. Have them share the legends with the class. Ask if anyone else had heard of that legend and if so, is their version exactly the same.

MAIN ACTIVITY:

Discuss with the class the different ways that climates can affect habitats. Ask the students to describe differences between how the Nova Scotia climate is in the winter versus the summer. How does that change affect the different animals and their habitats? What do some animals do during the winter in order to deal with this change of climate in their habitat (migration of hibernation)?

Inform them that they will be looking into a myth about how the turtle decided to deal with the winter climate of its habitat.

Read the Mi'kMaq Legend of the Turtle out loud in class. Distribute the legend sheet with the questions and have the students first read the questions, then read the story again themselves before attempting to answer them.

CONCLUSION:

When the students finish answering the questions they are to attempt writing their own imaginary legend. There are suggestions on the handout sheet for possible legend topics. Make sure that they know they can be as creative as they like because this is not a factual explanation as to why specific things happen or have happened, but a fanciful account.

Additional Activities

Mathematics:

- Pick a location that the class thinks would be nice place to migrate to and find the distance from your school (approx. as the crow flies).
- Adapt additional math questions around it. For example, "If a goose flies ____km/h, how long would it take to fly there?"

Language Arts:

- Write a story about what it would be like if you could hibernate for the winter.

Science:

- What are the scientific truths behind the Legend of the Turtle?
- How does an animal's body change when it hibernates?

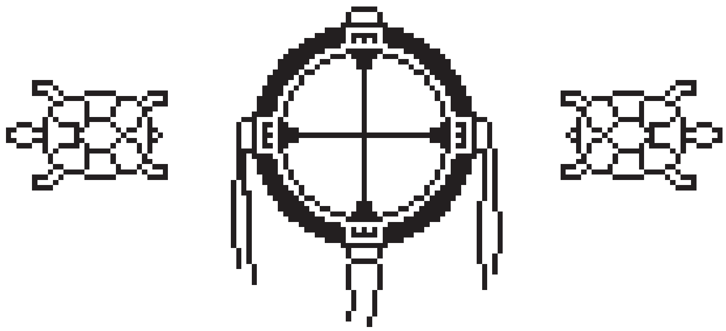
Visual Arts:

- Illustrate the legend. Have the students section the legend into possible scenes and then groups can create their own story board of illustrations.
- Compare the different groups' interpretations.

History:

- Look at the history of the Mi'kMaq in Canada, Nova Scotia, and/or Glooscap Bay.
- Why was the term "Indian" once used to refer to Native people and why is the term now discouraged?
- A further discussion could tackle the historically used term "savages" vs. "civilized". The discussion would be used to point out that the native people that existed here prior to the European explorers were already living in complex civilizations. They had different forms of government, religion, trade, and other aspects of living that are often considered as needed in order to be referred to as a civilization.

The Mi'kMaq Legend of the Turtle



In the long ago, turtle was the great storyteller of all the birds and animals of Glooscap's land. During the summer he had many friends, but when the cold Winter King came from the northland, most of the birds flew south to the home of the warm Summer Queen and many of the animals hibernated deep underground. Turtle did not know how to do this. He walked so slowly that the cold Winter King soon caught up with him. He nearly froze. He was so very cold and lonesome.

However, his great friendliness was his way to rescue. He talked to the geese about taking him to the warm south. They agreed to do so only if they could find some way to stop turtle from talking, for he was a bore to the geese who liked to honk their tales far and wide. The wily geese found a way. They carried turtle by his mouth on a stick and, of course, once off the ground he didn't dare open his mouth.

He did not enjoy his stay in the land of the Summer Queen. It was too warm in his heavy shell and he missed many of his dear friends. The next summer the maidens of the Queen brought him back to Glooscap's land and taught him how to hibernate.

It is said that if you find a turtle hibernating from the cold of the great Winter King he will be deep under the soil telling stories all winter long to his many friends.

Legend Activity Sheet

Name : ___________________________

Date : ____________

What saved the turtle by being "his way to rescue"? ____________

What is meant by the geese "liked to honk their tales far and wide"? ____________

Why did the turtle not enjoy the land of the Summer Queen? ____________

What did the maidens of the Queen teach the turtle? ____________

Where do turtles hibernate? ____________

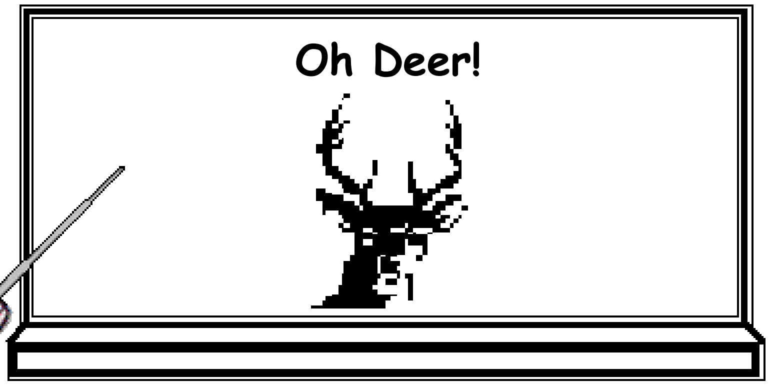
What does the legend say that the turtle does all winter long? ____________

Write your own legend!

Pick one of the following and write a small legend about it.

- Why there are seasons
- Why there are climates
- Why trees grow together to form forests
- How different Islands or Bays were formed
- Why the frog is born under water
- Why there were ice ages
- How a specific creature in Nova Scotia aquired a unique characteristic
- Why the ocean has salt water
- Why the Earth is the temperature that it is
- Why the Earth has ice caps
- Why any specific climate characteristic exists

Habitat : Lesson #4



OBJECTIVES:

Students will be able to

- identify and describe food, water, and shelter as three essential components of habitat
- point out how animals adapt to different areas
- describe the importance of good habitat for animals
- define "limiting factors" and give examples
- recognize that some fluctuations in wildlife populations are natural as ecological systems undergo a constant change

MATERIALS:

large playing area, two long ropes, chart paper, marker

PROCEDURE:

INTRODUCTION:

This activity is adapted from the Project Wild Activity Guide. Begin by telling the students that they are about to participate in an activity that emphasizes the most essential things that animals need in their habitat in order to survive. Review the fundamental necessities of animals: food, water, shelter and space. Inform them that space will not be dealt with in this lesson but to remember that it is still an extremely important aspect for a creature's survival.

Divide the students into four groups by having the students count off in fours, with all those sharing the same number gathering in certain corners of the play area (yard, gym or class). Make two parallel lines with the ropes, about 9 to 18 metres apart. Have the “ones” line up behind one line while the rest of the students line up behind the other line.

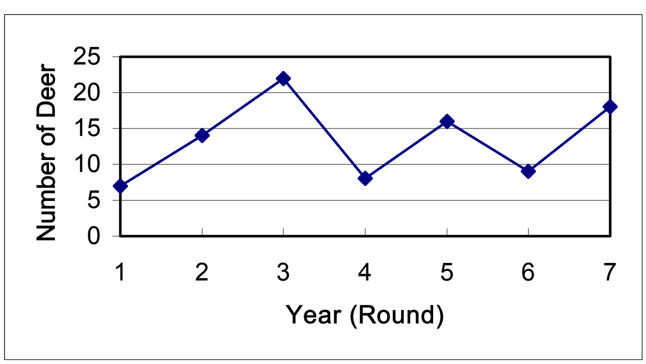
The "ones” become the deer. The other students become the components of habitat that they will pick themselves later. Ask the class to remind you what the different aspects of habitat are. Once they mention food, water, shelter, and space, tell them that we can assume the deer have enough space in this situation so the students who are the habitat components will only represent food, water, and shelter.

MAIN ACTIVITY:

When any of the deer are looking for food, they should clamp their hands over their stomachs. When they are looking for water, they put their hands over their mouths. When they are looking for shelter, they hold their hands together over their heads. The deer can choose to look for any of these needs during each round, but they cannot change what they are looking for in that round. Those that survive can change in the next round. The students who are the components of habitat may choose which they will be at the beginning of each round. They will depict that component in the same manner as the deer.

The game starts with all players lined up on their respective lines and with their backs to the students at the other line. You ask all the students to pick their sign and show it clearly. When they are ready, count: "One...two...three." At the count of three, the students turn and face each other showing their signs.

The deer run to the habitat component they are looking for while still holding up the sign for what they are looking for. They then take the student with that component sign back to the deer side of the line. This represents the deer's successfully meeting its needs and reproducing as a result. Any deer that fails to find the component it was seeking dies and becomes part of the habitat, joining the students on the habitat component side. You keep track of the number of deer at the beginning and ending of each round. Continue play for fifteen rounds. Keep the pace brisk so that the students will enjoy it. You should make a line graph of the number of deer alive at the beginning of each round to show that it is naturally cyclical.



DATA INTERPRETATION:

At the end of fifteen rounds discuss the activity; encouraging the students to talk about what they experienced and saw. The herd grows in the beginning, and then some must die as the habitat is depleted. This fluctuation is a natural cycle unless factors that limit population become excessive. Point out that this is one way that habitats can change naturally.

FOLLOW-UP:

Ask for some suggestions on ways that water, food, and shelter can naturally affect and throw off the cycle. Drought can cut out the supply of water, fire can destroy the shelter, and new species of animals introduced to the area can take all the food. The activity can be repeated with some of the suggested influences. While all the students have their backs to each other and their symbol chosen, go along the line of habitat components and tap any student on the head that is representing a component affected by the unique event. Silently, the students tapped must change their symbol to something else. The students representing the deer should not be told what components will not be represented that round. Therefore, if you decide to represent a drought, all the deer looking for water will die off. Keep track of the data for this situation and compare it to the previous data.

CONCLUSION:

The activity can be developed even further to discuss ways that people can harm the habitat components and therefore the deer's population. Also, the negative effect of Climate Change caused by people can be demonstrated directly by repeating the activity with an increase in the number of droughts, fires started by lightning, and decrease in food because of animals migration patterns being thrown off by the global changes.

BACKGROUND CHECK!

Ecological Footprint

Many of us live in cities where we forget that nature works in closed loops. We go to the store to buy food with money from the bank machine and deposit waste in a back alley or by flushing it down the toilet. We sometimes forget that nature provides us with a steady supply of the basic requirements for life. If we are to live sustainably, we must ensure that we use the essential products and processes of nature no more quickly than they can be renewed and that we discharge wastes no more quickly than they can be absorbed. Today, however, accelerating deforestation and soil erosion, fisheries collapse and species extinction, the accumulation of greenhouse gases and ozone depletion tell us that our current demands on nature are compromising humanity's well-being.

With this in mind, William Rees and Mathis Wackernagel have been studying and teaching a concept called the *Ecological Footprint*.

This concept provides a metaphorical way to understand the concept of *Appropriated Carrying Capacity*, the measure of our land use, over and beyond our immediate territory. After all, human settlements do not affect only the area where they are built.

An ecological footprint is the land that would be required on this planet to support our current lifestyle forever. A group's ecological footprint can be used to measure current consumption against projected requirements and likely shortfalls. In this way, it can help us to assess the choices we need to make about concerning our demands on nature.

The ecologically productive land per person on Earth has decreased over the last century. Today, there are only 1.5 hectares of such land for each person, including wilderness areas that probably shouldn't be used for any other purpose other than as a wilderness. Yet the present ecological footprint of a typical North American is about 4 to 5 hectares. This represents three times his/her fair share of Earth's bounty. If everyone in the world lived like the average North American, we would need at least three planets to live sustainably.

Key Words

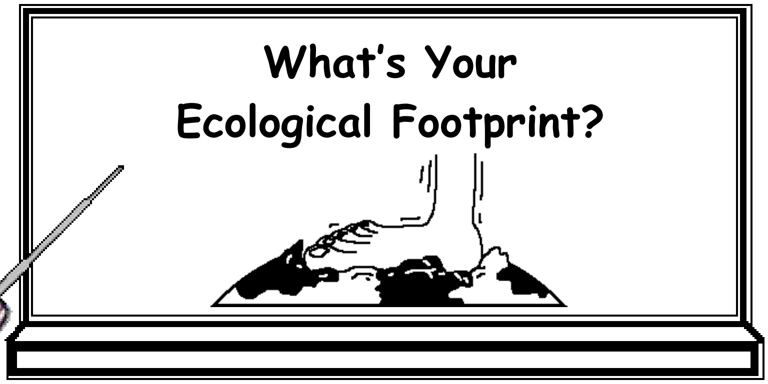
Ecological Footprint, Appropriated Carrying Capacity

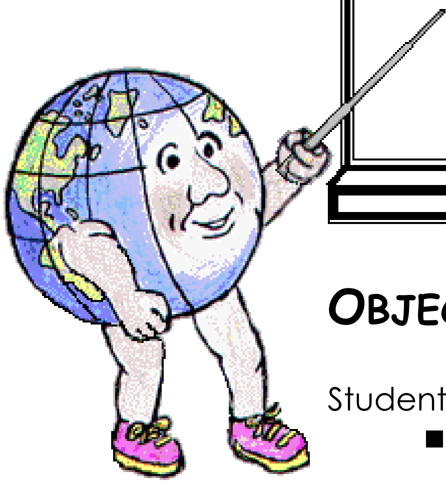
Sources

Ecological Footprint Questionnaire
http://www_heb.pac.dfo-mpo.gc.ca /community /education/lessonplans/ecofootprint/ecofootprint_e.htm

Our Ecological Footprint, Reducing Human Impact on the Earth, William Rees and Mathis Wackernagel, New Society Publishers, Canada, 1998

Habitat : Lesson #5





OBJECTIVES:

Students will be able to

- brainstorm sources of energy resources used by typical Atlantic Canadian populations
- relate the Ecological Footprint concept to their own lives
- compare their footprint to the Canadian average and to those of other countries
- write personal energy reduction goals based on the results of a questionnaire

MATERIALS:

Copies of Ecological Footprint Quiz, class set of calculators (optional)

PROCEDURE:

INTRODUCTION:

Before beginning the activity, find out the population of the school and approximately how many metres square the school is in area.

Brainstorm with the class or in smaller groups the kinds of things we find in a typical city (cars, buildings, restaurants, grocery stores, etc.). Write these words on the board underneath a semi-circle that represents a dome enclosure over the city. Explain to the students that most if not all of these words exist only because of resources outside of the city.

Go back to each of the words and brainstorm their sources. Use arrows to trace elements of the city to the resources outside of the city. For example, restaurants get their food from grocery stores, which get their food from suppliers, which get their food from farmers who grow their food on farms. Some of these farms may even be on the other side of the world.

Enlarge the dome enclosure to show that the city really uses a lot more of Earth's land than we think. In other words, it takes a lot of land to support the city. Discuss the Ecological Footprint concept, the idea that individuals and groups can measure how much of the Earth's land they "take-up" as a result of their lifestyle choices.

MAIN ACTIVITY:

On the first day, lead the students through the questions and answers of the questionnaire. Assign the Living Space (home) calculation at the end of the questionnaire for homework. Set aside some time in the two days following, for students to work independently to complete the questions again. On the third day, work with the children to add up their questionnaire scores and determine the number of hectares they use.

FOLLOW-UP:

Ask the class to imagine if everyone in the world lived like an average Canadian. Then, ask them to guess how much land would be needed to sustain everyone if that were the case. Take a show of hands for the following answers and display the number of students who chose each.

a) ¾ of the world's usable land
b) the entire planet's usable land
c) 2 planets worth of usable land
d) 3 planets worth of usable land

Write the average Canadian's amount (4.3 ha) on the board and then tell them that the World only has enough usable land to dedicate 1.5 ha per person. Have a volunteer from the class either use a calculator or the board to work out approximately how many Earths would be needed. The calculation is 2.7; therefore the answer is "d) 3 planets worth of usable land" would be needed.

CONCLUSION:

Copy the following information onto the board or use an overhead projector.

A population of people	The average land use per person
U.S.	5.1 ha
Canada	4.3 ha
India	0.4 ha

Available land on the planet per person = 1.5 ha

Discuss with the class how two of the North American countries (U.S./Can.) compare to India and the amount of available land per person. Brainstorm ways the class might reduce its Ecological Footprint. Have students write their personal goals and ideas as to how to best reduce the size of their footprint.

You may want to try this activity at the beginning of the year and then again at the end of the year in order to make a comparison.

Additional Activities

Mathematics:

- Have each student calculate how many worlds would be needed if everyone on the planet used as much land for their footprints as the student used in his or hers.

Language Arts:

- Divide the class in half. Half write "World Wanted!" postings for the "Intergalactic News" while the other half of the class represent distant galaxies advertising "Worlds For Sale!". The advertisements should include prices, descriptions, mode of transporting the planet, etc.

Visual Arts:

- Create a bulletin board. Have students all decorate their own footprint. They can trace their actual foot onto paper and then decorate it with pictures (drawn or cut out of a magazine) of what their Ecological Footprint includes (ex, farming, mining, electrical plants, grocery stores, home, school, etc.).

Name: ______________________________

Dates: Day#1__________
Day#2__________
Day#3__________

Ecological Footprint Questionnaire

Your ecological footprint is a measure of how much land you use through everyday activities. The following questions will help you to see how big your ecological footprint is and how choices you make can shrink or expand the size of your footprint.

Transportation

How did you travel yesterday?

I walked	0	I carpooled	15
I cycled	5	I used a private vehicle	30
I took public transport	10		

Multiply each score by the number of times you used that method of travel to move from one location to another in one day and add them together to to find your total score for the day.

______ Day 1 Total Score	______ Day 2 Total Score	______ Day 3 Total Score

Water Use

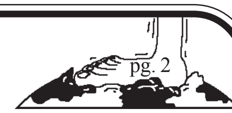
How much water did you use to shower or bathe yesterday?

I did not shower/bathe	0	10 minute shower	20
1-2 minute shower	5	I bathed in a half tub	20
3-5 minute shower	10	I bathed in a full tub	30

I reused someone else's bathwater 10

I left the water running when I brushed my teeth 5

______ Day 1 Total Score	______ Day 2 Total Score	______ Day 3 Total Score



Clothing

1) I am wearing __ of the same clothes today as I wore yesterday.

Most	0	Some	5
None	10		

I am wearing something that has been mended -5
I did the mending -5

2) At least half of all my clothes are second-hand.
(Answer question on Day 1 only)

Yes 0 No 20

______ Day 1 Total Score	______ Day 2 Total Score	______ Day 3 Total Score

Recreation

1) How much equipment did you need to participate in games, sports, and activities yesterday?

None or little	0	Some	10
Quite a bit	20		

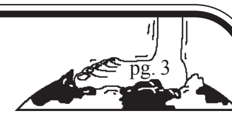
2) How much land was converted into playing fields, ice rinks, pools, gym space, ski runs, etc. to meet your recreational needs?

None or little	0	Some (< a hectare)	10
Quite a bit (> a hectare)	20		

3) I spent the following today on food, clothing, magazines, sports equipment, etc.

Nothing	0	Ten dollars	10
Five dollars	5	Over ten dollars	(1 per $)

______ Day 1 Total Score	______ Day 2 Total Score	______ Day 3 Total Score



Food

1) I ate the following portions of meat yesterday.

None	0	Two portions	20
One portion	10	Three portions	30

2) This much food was left on my plate yesterday.

None	0	A little	5
More than a little	10		

3) The food I ate yesterday was locally grown.

All	0	Some	10
None	20		

4) The food I ate yesterday was packaged in paper or plastic.

None	0	Some	10
All	20		

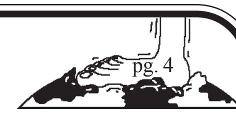
______ Day 1 Total Score	______ Day 2 Total Score	______ Day 3 Total Score

Garbage

If I were to take everything I threw into the garbage yesterday and put it all into the same container, I would need this size of a container to hold it all.

A crate	30	A cup	5
A shoe box	20	I produced no garbage	0

______ Day 1 Total Score	______ Day 2 Total Score	______ Day 3 Total Score



Living Space

Calculate in square metres the indoor space that you require to live for three days. Include all the space in your home, school, etc. Divide the total square meters by the number of people you share the space with.

Home (square metres / # of people) = _____

School (square metres / # of people) = _____

Cottage (square metres / # of people) = + _____

____
Total Living Space per person

Add It Up

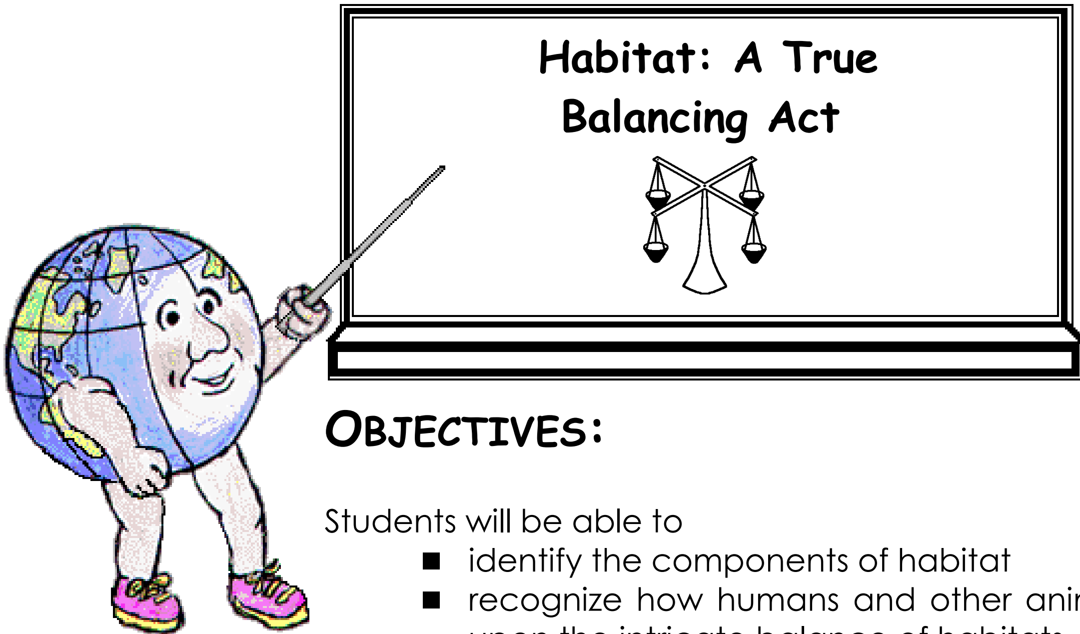
Enter the appropriate numbers with one digit in each square. Line the numbers along the right side. For example, if the number is only two digits long, like 42, leave the first square blank, put 4 in the next square, and then 2 in the last square.

Total Living Space =				
Total of all Day 1 scores =				
Total of all Day 2 scores =				
Total of all Day 3 scores = +				
Grand Total =				

Convert your Grand Total from above into your personal footprint for the three recorded days by dividing it by 100.

My Ecological Footprint is ___ hectares.

Habitat : Lesson #6



OBJECTIVES:

Students will be able to

- identify the components of habitat
- recognize how humans and other animals depend upon the intricate balance of habitats
- interpret the significance of loss or change in habitat due to climate change

MATERIALS:

(none needed)

PROCEDURE:

INTRODUCTION:

This activity is adapted from the Project Wild Activity Guide in order to take into consideration how Climate Change can affect habitats. The major purpose of this activity is for students to become familiar with the components of habitat, and to recognize that just having food, water, shelter and space is not sufficient by itself for animals to survive - those components of habitat must be in a suitable arrangement. This activity takes very little time - but can have a lot of impact!

MAIN ACTIVITY:

Ask the students to number off from “one” to “four”. All the “ones” go to one corner of the room, the “twos” to another, etc. As the students move to their corners, clear a space in the centre of the room. Better still, go outside to a clear, grassy area. Assign each group a concept as follows: “ones” food, “twos” water, “threes” shelter, “fours” space.

Now, it's time to form a circle! This is done by building the circle in chains of food, water, shelter, and space. A student from each of the four groups walks toward the cleared area. The four students stand next to each other, facing in toward what will be the center of the circle. Four more students - one from each group - join the circle. Keep adding to the circle in sets of four until all the students are in the circle.

All students should now be standing shoulder to shoulder, facing the centre of the circle. Ask the students to turn to their right, and take one side step toward the centre of the circle. They should be standing close together, with each student looking at the back of the head of the student in front of him or her.

Don't panic - this will work. Ask everyone to listen carefully. Students should place their hands on the shoulders of the person in front of them. At the count of three, you want the students to sit down... on the knees of the person behind them, keeping their own knees together to support the person in front of them. You then say, “Food water, shelter, and space in the proper arrangement (represented by the students' intact, “lap-sit” circle) are what is needed to have a suitable (good) habitat”.

The students at this point may either fall or sit down. When their laughter has subsided, talk with them about the necessary components of suitable habitat for people and animals.

CLIMATE CHANGE ASPECT:

After the students understand the major point - that food, water, shelter, and space are necessary for any animal's survival and, in their appropriate arrangement, comprise a suitable habitat - let the students try the circle activity again! This time ask them to hold their lap-sit posture. As the students lap-sit - still representing food, water, shelter, and space in their appropriate arrangement - identify a student who represents “water”. Then say, “ It is a drought year because of Climate Change from global warming. The water supply is reduced by the drought conditions”. At this point, have the students who were identified as “water” remove themselves from the lap-sit circle - and watch the circle collapse, and suffer from the disruption in arrangement.

You could try this in several ways - removing one or more students from the circle. Conditions could vary: pollution of water supply due to rising water levels contaminating coastal area water, soil erosion impacting food supply, lightning from increased severe weather causing forest fires and destroying shelter, animals migration routes changed due to temperature increase and therefore can not find neither food nor space, etc. Since animals' habitat needs depend upon food, water, shelter, and space in their appropriate arrangement, “removal” of any will have an impact.

CONCLUSION:

Ask the students to talk about what this activity means to them. Ask the students to summarize the main ideas they have learned. They could include:

- food, water, shelter, and space, in their appropriate arrangement can be called a habitat;
- humans and other animals depend upon habitat;
- loss of any of these elements of habitat will have a serious impact on the animals living there; and
- changes in the world’s climates because of global warming, resulting from increased Greenhouse Gasses, can destroy habitats by directly affecting it’s elements.

Background Check!

Plant Watch

The Nova Scotia Plant Watch Project, formed in 1996, examines flowers typical to our region to see what they can tell us about major weather changes. So far, two hundred volunteers across Nova Scotia recorded the spring flowering times of the twelve plants. These particular plants were chosen for their known sensitivity to spring temperature rather than the seasonal light changes that prompt the flowering of our summer flowers and trees. The main species are native wild flowers and trees found in most parts of Nova Scotia, so everyone in the province has a chance to plant watch. Some plant immigrants were also chosen - like the dandelion which is important for our honeybees, purple lilac which has a long history of phenology studies, or Forsythia and Coltsfoot which are very accessible to both town and country folk. This way, everyone has a chance to watch at least a few of the 12 sensitive species. All records are useful and it is not essential to record all the species.

Nova Scotians are particularly fortunate to have a very detailed historical record from the end of the last century for comparison of modern data with century-old records. This record comes from the pioneer work of Alexander H. MacKay, superintendent of Education in Nova Scotian schools from 1891 to 1927. MacKay taught nature studies that involved observing and recording phenology and he set up a network of Plant Watch centres in 400 schools across the Province. Students and teachers became his fieldworkers for discovering and recording the natural world at the turn of the Century! MacKay and his students made a total of 100 phenological observations were made each year, including first flowering and fruiting of many native and cultivated plants, the first appearance of migratory birds, dates of hay-cutting and sheep-shearing as well as important weather events, like hurricanes and hailstorms.

The preliminary comparison between MacKay's data and the present survey shows that there may be little change in flowering dates over the past century. But remember that the spring and summer of 1996 were particularly cold and wet in Nova Scotia! It may drastically change in 2002, 2003 and beyond!

Key Words

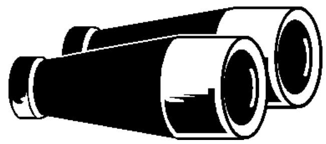
Plant Watch, Phenology, Flowering Times, MacKay

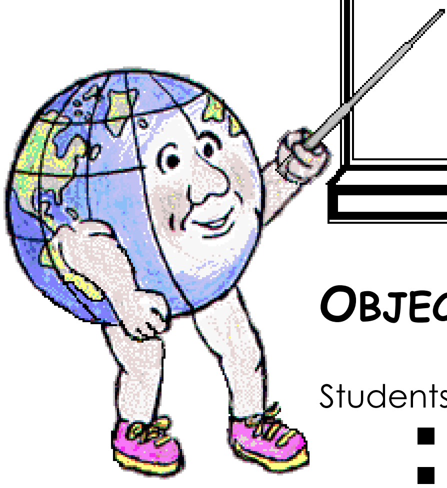
Contact

Nova Scotia Plant Watch
Melanie Priesnitz
K.C. Irving Environmental Science Centre & Harriet Irving Botanical Gardens
Acadia University
Wolfville, NS B4P 2R6
ph: (902) 585-1916
fax: (902) 585-1034
melanie.priesnitz@acadiau.ca
http://botanicalgardens.acadiau.ca

Habitat : Lesson #7

Plant Watch





OBJECTIVES:

Students will be able to

- describe local habitat, soil, and light conditions
- determine local plant flowering times
- record their observations in charts
- compare their observations with others to explore climate changes over a period of time

MATERIALS:

Class set of Plant Watch Observation Table and Plant Watch Observation Chart, Previous Plant Watch Data overhead, list of local species to be observed, plant books containing information about those species of plants, Internet access (optional)

PROCEDURE:

PREPARATION:

Photocopy the Plant Watch Observation Table to the back of the Planet Watch Observation Chart. Make a class set of these double sided handouts.

Choose one or more of the following 14 species for the students to observe. Some may be easier to find in your particular school or home neighbourhoods. Information about each plant and pictures of them in bloom can be found at the web site: (http://www.plantwatch.ca). Check the web site for updates to the species list and possible procedure changes such as the definition of “first bloom”.

PLANT SPECIES LIST

Common Name	Latin Name
Coltsfoot	(Tussilago farfara)
Mayflower	(Epigaea repens)
Trembling Aspen	(Populus tremuloides)
Red Maple	(Acer rubrum)
Weeping Forsythia	(Forsythia suspensa)
Tamarack/Larch	(Larix laricina)
Bluets	(Houstonia caerulia)
Star-flower	(Trientalis borealis)
Clintonia	(Clintonia borealis)
Rhodora	(Rhododendron canadense)
Purple Lilac	(Syringa vulgaris)
Bunchberry	(Cornus canadensis)
Dandelion	(Taraxacum officinale)
Wild strawberry	(Fragaria virginiana)

(Check web site for possible additions to list)

INTRODUCTION:

Review terms like *habitat* with the students. Explain that over the next few weeks the class will be making some important observations about habitat and plants in their neighbourhoods.

Discuss with the students the importance of collecting data. Brainstorm possible data that scientists might want to collect. Also, brainstorm reasons for and the importance of collecting information about plants and animals over a period of years, decades, or even centuries.

Show the students the plants you have chosen to observe. Have students look through plant books or on the Internet to find more information about these plants. Share some of the history of these plants with the entire class.

MAIN ACTIVITY:

Provide each student with the chart and table handout. You may make observations as a class or assign them as homework depending on your school's location and accessibility to varied plant life.

Brainstorm with the students areas you may wish to observe. Assign students to particular areas. Ensure students are aware of the rules of observation:

- Try not to walk on plants or damage the area while observing.
- Don't go into the woods after dark.
- Always be able to see a house or community centre easily from where you are.
- Always make sure an adult knows where you are at all times.

Students will need to make some preliminary observations before plants begin to bloom. Discuss these observations and updates briefly each day as a class.

As the flowers begin to bloom, put students in charge of observing their area each day until they have completed their charts. As a class, discuss the observations. Have students compile their charts and send them to Plant Watch.

CONCLUSION:

Students should try to explain how their data could be used to explore the phenomenon known as Global Warming due to the Greenhouse Effect. Show them the Previous Plant Watch Data overhead and ask them if they see a pattern in the mean temperatures listed at the bottom of the chart. Then, they should compare the "1st Bloom" categories for the 1892-1923 survey and the 1996-98 in order to determine whether the plants are being affected by Global Warming. The "50% Bloom" category can also be compared between the 1892-1923 survey and the one done in 1999. Students should see if their data follows the trends demonstrated in the data.

Additional Activities

Mathematics:

- Students could use their own data and the data given on the Previous Plant Watch Data sheet to calculate how many days on average plants are blooming earlier than plants watched in the previous data collections.

Language Arts:

- Students can create their own poems (any format) concerning one of the specific plants on the plant watch list. Here is one as an example:

  The mayflower buds
  in simple beauty bring
  Home to the heart the first
  glad thoughts of Spring;
  - from the poem "Acadia"
  by Joseph Howe

Visual Arts:

- Students could draw a series of pictures of one of their plants at different stages of blooming and date them as pictorial study data.

Nova Scotia Plant Watch Observation Table

Here is a list of code numbers which match the habitat, soil, light conditions, and number of plants you will see during your observation. Carefully record the appropriate numbers in the *Observations* section of your Observation Chart.

What kind of HABITAT do you see?

Hardwood (deciduous) forest (e.g. maple)	1
Softwood (conifers such as spruce) forest	2
Mixed forest	3
Alder and shrubs	4
Grassland and farmland	5
Abandoned farmland	6
Marsh, bog, and wetlands	7
Roadsides	8
Parking lots	9
Residential garden and lawns	10
Industrial or commercial site (e.g. side of a store)	11
Empty lot	12

What kind of SOIL do you see?

Rich and loamy	13
Rocky	14
Sandy	15
Water saturated/muddy	16

What kind of LIGHT do you notice?

Full sunlight	21
Shady areas	22
No sunlight	23

How many PLANTS do you see?

1 or 2 individuals	31
Fewer than 25 plants	32
More than 25 plants	33
More than 100 plants in a radius of 3 m (10feet) around you	34
More than 1000 plants in a large group	35

Do you have any other observations?

Are you on flat land or a hill?
If you are on a hill, what side is it facing? (north, east, south, west)
Are there dead trees? (none, a few, several)
Is it a windy place?
Has there been any unusual weather recently?

Plant Watch Observation Chart

Instructions: Write the date of your observations underneath the appropriate flowering data column. Here's the tricky part. Don't record the date like you normally would. Instead, write only a number to show the number of days into the year the date falls. For example, January 31 = 31 BUT February 28 = 59, March 31 = 90, April 15 = 105, April 30 = 120, May 15 = 135, May 31 = 151, June 15 = 166, and June 30 = 181. Don't forget to record the code numbers found in the Observation Table (should be on reverse side of this sheet) for your observations of habitat, light, soil, and sunlight.

Species	Flowering Dates			Observations
	First 10% In Bloom	Mid Bloom Half The Flowers	Full Bloom (90%) Almost All Flowers	

Observer's Name: ____________________
School Name: ____________________
Mailing Address: ____________________
Telephone: ____________________
Email: ____________________

Location of Observation: ____________________
Nearest Town: ____________________
Nearest Crossroad: ____________________
Longitude/latitude (if possible): ____________________

PREVIOUS PLANT WATCH DATA

Species	MacKay's Survey (1892-1923)		1996-98		1999	
	1st Bloom	50% Bloom	Mean 1st Bloom	1st Bloom	50% Bloom	Full Bloom
Coltsfoot			112	92	98	110
Bluets	134	141	134	128	132	140
Weeping forsythia			128	117	121	124
Mayflower	106	116	120	108	113	116
Tamarack			132	124	129	130
Red maple	128	134	126	115	120	125
Trembling aspen	120	124	122	110	116	120
Purple lilac	159	165	148	142	146	150
Starflower	148		148	142	144	148
Bunchberry	151	156	150	144	147	149
Rhodora	147	153	158	138	140	143
Clintonia	153	159	151	143	145	150
Dandelion			122	118	123	130
Wild strawberry			129	126	130	135
Mean Temp.		6.3 C	6.9 C		7.8 C	