People for Energy and Environmental Literacy (PEEL)

Lesson Plan 1

Understanding Climate Change Causes and Evidence

Basic Level
Intermediate Level
Advanced Level

Date: January 2019
Version 1.2

PEEL is supported by the Community Environment Action Program. This project is offered in partnership with GreenLearning Canada Foundation, provider of free online education programs about energy, climate change and green economy.

Alberta

Summary of Activity

Grade: 3 – 12 Subject: Science, Social Studies

Time: 1.5 - 2 Hr Theme: Climate Change

Description: Learn about climate change causes and effects. Discuss how climate change works and the impact we have on this natural process. Students will finish the lesson with more questions and curiosity, and interest to pursue the other lessons in the program.
Three presentations are available:
Basic level – Grades 3-5
Intermediate level – Grades 6-8
Advanced level – Grades 9-12

What's included: Powerpoint file – Climate Change 101 – Basic Level (Grades 3-5)
Powerpoint file – Climate Change 101 – Intermediate Level (Grades 6-8)
Powerpoint file – Climate Change 101 – Advanced Level (Grades 6-8)
Each powerpoint file has notes for each slide with questions and advice for the instructor.

The lesson can be completed over two over two classes periods.

Overview

Students are taught the various components of climate change; from how it has occurred historically, to how we are impacting the cycle, and the implications that result from it. Students will also learn how climate change and global warming are related but are different.

This lesson is set up as a foundation for the other lessons. It teaches students the basic knowledge for the other topics, and illustrates why striving for a more sustainable environment is important. The goal of this lesson set is to strike interest and awareness in the students.

There are four videos, plus one optional video, that requires up to 15 minutes to view them all. We recommend that all links to each are loaded prior to starting the lesson. Sound is required for all videos. To access the video, click the links on the presentation slide while in presentation mode.

Curriculum Links

The table below provides a guide to some of the curriculum links between this lesson plan and grades and subjects.

Alberta

Table 1: Curriculum links to this lesson plan

	SUBJECT			
Grade Level	**Science**	**Social Studies**	**Career & Technology Studies**	**Environment and Outdoor Education**
3	Animal life cycles	Global Citizenship	• Environmental Stewardship Occupational Area, • Forestry Occupational Area, • Primary Resources Occupational area, • Wildlife Occupational Area, • Agriculture Occupational Area	• Part of a complex global environment • Human life and life styles are dependent on environmental resources • Humans influence environment through direct and indirect means. • Principles of conservation
4	Waste and Our World	Alberta: A Sense of Land		
4	Plant Growth and Changes	Alberta: Celebrations and Challenges		
5	Weather Watch	Physical Geography of Canada		
5	Wetland Ecosystems			
6	Trees and Forest	Citizens Participating in Decision making		
7	Interactions and Ecosystems			
7	Plants for Food and Fibre			
7	Heat and Temperature			
8	Freshwater and Saltwater Systems			
9	Biological Diversity	Issues for Canadians: Economic System in Canada and the United States		
9	Environmental Chemistry			
10	Energy and Matter in Chemical Change	To what extent should we embrace globalization?		
10	Energy Flow in Technological Systems			
10	Energy Flow in Global System			
10	Stewardship			
11	Science Technology and Society	To what extent should we embrace nationalism?		
11	Chemical Changes			
11	Changes in Living Systems			
12	Chemistry and the Environment	To what extent should we embrace ideology?		
12	Energy and the Environment			

In addition to curriculum links, there are also direct links to the Alberta 21st Century Learner competencies.

Figure 1: Alberta 21st Century Learner Competencies

This lesson focuses on the following learner competencies:

- Cultural and Global Citizenship
- Problem Solving
- Critical Thinking

Energy and Environmental Learning Outcomes

Students are to understand the importance of climate change and how humans are an integral part of its cause. They are to know the major differences between climate change and global warming, and examples of each. By the end of lessons, students should demonstrate actions to make a change and to seek alternative options in everyday life that are more sustainable and environmentally friendly.

Summary of key concepts are listed below:

- The greenhouse effect and greenhouse gases
- Human activities are a significant contributor to global warming through burning fossil fuels
- Evidence of climate change and global warming
- Alberta and Canada's emissions in comparison with the rest of the world.
- Students learn about their circle of influence and control
- Options for student's choices are presented.
- Activities
    - Popcorn Activity (Intermediate and Advanced level)
        - Timeframe to reach 2 degrees Celsius change is completed through an activity
    - Melting Ice Sheets Experiment (Advanced level)
        - Understanding the ice-over-land or ice-on-water impacts to global sea level

Planning Notes

Materials

- Climate change 101 power point presentation (different versions available as applicable)
- Popcorn Activity (Intermediate and Advanced level)
    - Popcorn activity kit (please contact PEEL to sign out or purchase a kit). Kit includes popcorn containers, country labels, scoops (Participants to provide their own popcorn)
    - Approximately 40 litres of popcorn.
- Ice Melt Experiment (Advanced level)
    - Ice, water and two clear plastic containers (size 2 cups) with lids that are perforated.
    - Warming devices are useful (fan, blow dryer, etc.) but are not essential.

Participants

- Thirteen volunteers for the popcorn activity.

Prior Learning

This lesson outlines the foundations of climate change science applicable to all grades. Students with advanced knowledge can explore the other components of climate change, which are in line with the Alberta curriculum learning competencies through this lesson. Each element of this lesson plan is in line with the units of study in the Curriculum Links section above.

Teaching/Learning Strategies

The topic of climate change will be taught through presentations, handouts, and hands-on activities. As the lesson progresses, students in the higher grades may participate in an individual or group project where they research the answers to questions that may have risen in their learnings.

Instructions

Pre-activity discussion

It is beneficial for teachers to review the following concepts with students before the session:

- average
- atmosphere
- per person, or per capita
- tonne
- parts per million (PPM)

It is highly beneficial for teachers to focus on the circle of influence.

Activity

Students will be presented the Climate Change 101 presentation. This presentation outlines the basis of climate change and gives the students a foundation to further their learnings in the following years.
Two activities can be completed on popcorn and ice sheets.

Post-Activity questions (Follow up questions)

Questions should be related to the circle of control and the circle of influence so that students can take some action and have some control. Activity sheet on "What can I do?" can be filled out by the students.

Extensions

Several extensions are available for higher grades, and these are in the form of research and analysis.
Topics include:

- SCIENCE
    - Global Warming Potential. Global warming potential (GWP)is developed to allow for a comparison of the global warming impacts of different gases. Students can complete research on the different GWP levels for each of the greenhouse gases.
    - https://www.epa.gov/ghgemissions/understanding-global-warming-potentials
- MATH
    - National Inventory Report. The National Inventory Report is Canada's inventory submission to the United Nations Framework Convention on Climate Change. Research and analysis can be completed by students to understand the sources and locations of Canada's greenhouse gas emissions.
    - https://www.ec.gc.ca/ges-ghg
- SOCIAL
    - United Nations Framework Convention on Climate Change (UNFCC). UNFCC is an international environmental treaty adopted in 1992. The objective of the UNFCC is to stabilize greenhouse gas concentration in the atmosphere at a level that prevents dangerous interference with the climate system. Students can research information on the UNFCC and the treaties, agreements, and protocols such as Kyoto, Paris, etc. Students can review Canada's positions throughout the timeframe from 1992 under different governments.

Resources

- All resources are explicitly identified in the PowerPoint presentation in the notes section.

Print resources

Put in the actual documents they need here. (see attached)

Websites

- http://berkeleyearth.org/ - Independent analysis of global warming, the cause is not discussed on this website.
- https://climate.nasa.gov - NASA information on global climate change, information for educators, graphics and multi-media, climate kids, global warming versus climate change.

Videos

- https://www.youtube.com/watch?v=SzcGTd8qWTg - Educational information on Climate Change by Crash Course Kids and is a four-minute video. The video discusses the impacts on ecosystem and climate change. Suitable for Intermediate and Advanced grades. Published in 2016.

Publications

Supporting publications that can be helpful in this topic include:

- The Magic School Bus and the Climate Challenge
- The Down-to-Earth Guide to Global Warming, Cambria Gordon and Laurie David
- Our Choice – Young Reader's Edition – Al Gore

Data References

References are available in the climate change presentation under notes.

Feedback

We are continuously interested in improving and updating this lesson plan. Please send your feedback to info@teachpeel.ca.

ACTIVITY - POPCORN CLIMATE CHANGE

Big Idea: Climate change is real, and evidence indicates that it is caused by humankind. Our atmosphere is like a bathtub. Each country's emissions fill up the bathtub with carbon dioxide. Oceans and biologicals (trees etc.) remove carbon dioxide out of the atmosphere. We are putting in more carbon dioxide each year compared to the removal of carbon dioxide. The level in the bathtub is rising (carbon dioxide levels increase over time).

Materials: Popcorn Kit including:

- 12 Name Tags (representing China, USA, Canada, Indonesia, Europe, Japan, Russia, India, the Rest of the World, Biologicals, and Oceans).
- 12 measuring cups (specific sizes for each country, and biologicals and oceans). Each measuring scoop represents one year of source production/sink.
- Atmosphere tub with markings for emission levels at the Ice Age, 1950, 2015 top line showing 490 ppm CO_2e as the 2-degree Celsius change.
- Sequestration tub for all CO2 absorbed by the biologicals and oceans.
- Bucket Number 1 – 12-litre container of popcorn representing CO2 levels from zero to ice age.
- Bucket Number 2 – 6-litre container for popcorn representing the volume of CO2 added between ice age and 1950.
- Bucket Number 3 – 8-litre container of popcorn representing CO2 added to the atmosphere between 1950 and 2015.
- Bucket Number 4 – 15-litres of popcorn representing Country Emissions and is the source of the emissions (take the popcorn out of here).

Activity:

- Select 12 volunteers to represent carbon sources and sinks (sources are countries, and sinks are ocean and biologicals)
- Select another volunteer to track the number of years on the whiteboard
- Handout name tags and corresponding scoop to each volunteer.
- Line up the volunteers with Country name tags so that they can scoop from Bucket 4 – Country emissions and put the scoops into the Atmospheric bucket to represent one year of emissions from that country.
    - Carbon sinks (Ocean and Biologicals) then remove the popcorn from the atmosphere and put it in the sequestration tub to represent one year of sequestration from plants/trees and the ocean.
    - We recommend that you instruct a person to scoop 5-years' worth at first to reduce the total time that the activity takes.
    - As the level of the popcorn approaches the top of the box, reduce to one year of scoops at a time for all countries and sinks.

- The students count how many years it takes at current emission levels to get to 490 parts per million of CO_2 in the atmosphere, even with biological sequestration and oceans absorbing CO_2.

Possible Questions: (Please modify these questions to align with your student's needs.)

1. How do you feel about climate change urgency? Is this a problem we need to deal with now or can we wait for a period before we change things?
2. How do you feel about the emissions from the rest of the world (ROW) regarding absolute emissions and the emissions per person?
3. Are Canada's emissions significant on a per person basis, or an absolute basis?
4. Why are China's emissions so high?
5. Can Canada provide a leadership role in emission reductions?

Result: Children have a sense of urgency associated with change in behaviours and carbon emissions. Students will be able to identify the immediate need to reduce Canada's carbon emissions.

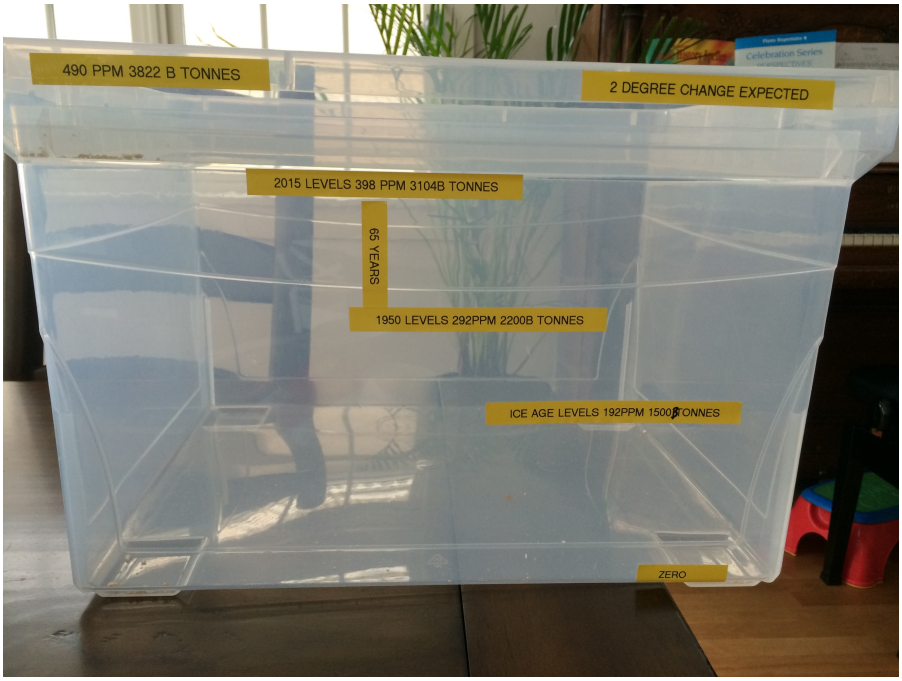


Figure 2: Atmospheric Carbon Dioxide Tub

Figure 3: Scoops used by each country and carbon sinks

Figure 4: Name Tags used in the popcorn activity

EXPERIMENT – Sea level Rise from Melting Ice Sheets

Big Idea: Sea level is affected by melting Ice sheets over land have a different impact compared to melting ice sheets in the ocean. The water level represents the sea level. The ice on the lid represents the ice on Greenland. The ice in the water represents the Arctic.

Problem: What causes sea level to rise more: melting ice sheets on land, or melting ice sheets in the ocean?

Manipulated variable:
Location of Ice Cubes

Responding variable:
Height of water rise in the container

Materials
Two 2-3 cup clear plastic containers with a clear plastic lid for one of the containers,
Pierce holes (6-10) in the top of one lid
Water filled with the same level of water.
Ice cubes (about 8-12)
Sharpie
Heating source (heater, hairdryer)

Steps:

1. Label the container with the lid (with holes) as Greenland
2. Label the other container as the Arctic
3. Place 4 ice cubes in one container called the Arctic.
4. Fill both the clear plastic containers with water to the same levels
5. Mark the water level with a sharpie on each container
6. Place 4 ice cubes on the lid of the Greenland container.
7. Place both containers in front of a heat source and wait until the ice has melted.
8. Ask students to identify the controlled variables and make a hypothesis.
9. Once both containers have the ice melted, then measure the change in water level of each container.

EXPECTED RESULT: The container with ice located on the lid, representing Greenland, will have a higher water level in the container compared to the container with ice located in the water, representing the Arctic.

Observation: Determine which container had a rising level of water.

Questions/Answers:
(Please modify these questions to align with your student's needs.)

- What are the implications of melting ice sheets on land versus melting ice in the Arctic? *Answer: Melting ice sheets on land will result in rising sea levels. Melting ice in the artic will not result in rising sea levels, however, will have an impact on wildlife and the ecosystem.*
- Where are ice sheets on land? *Answer: The largest ice sheets on land are on Antarctica and Greenland.*
- What evidence do we have of melting ice sheets on land? *Answer: NASA detailed tracking of Greenland's ice sheets.*
- What evidence do we have of rising sea levels? *Answer: NASA satellite sea level measurements demonstrate an increased rate of sea level rise.*

Result: Children understand the impact of melting ice sheets from Greenland and Antarctica have on rising sea levels.

ACTIVITY – ENERGY FLOW IN GLOBAL SYSTEMS – Advanced

Activity courtesy of Joshua Ouellet, M.Sc., B.Sc., B.Ed., Westmount Charter School, Alberta

Introduction

Global systems can be complicated and difficult to analyze. Climate systems can be particularly difficult to comprehend since multiple components interact with each other and can create difficulty discerning patterns. Many patterns require large data sets to be able to distinguish long-term trends. The central topic of inquiry for this investigation, which will serve as a platform for sub-investigations is ***what trends in climate data are evident at specific locations in Canada?***

Instructions

Inquiry & Data Acquisition

In a small group, investigate a climate record from a specific location (city, town, geographic area) in a ***biome*** in Canada (once you have picked a site, confirm with your teacher to ensure only one group is investigating each location). Download the data available for your site from the Environment Canada Website:

http://climate.weather.gc.ca/historical_data/search_historic_data_e.html

You can search by area or city. Download the monthly data available for your location and import the data into excel. See “How to download your data from Environment Canada” for instructions.

Analysis

Analyze your dataset. What variables are you going to choose to give you the best representation of the trend of the climate at your location over a specific interval? How are you going to compare multiple variables to distinguish if there is a perceivable trend in the data? What is the best way to represent your data to identify trends? What trends are evident in the data analyzed? Is the trend identified obvious and easy to distinguish or is it more difficult to identify within the data set? What is the rate of change of the variable(s) you investigated? What questions come up as you analyze your results?

Interpretation

How reliable is the data that you investigated? What is a good way to confirm that the results obtained are reliable? Does the data analysis you conducted provide *anecdotal* evidence or *scientific* evidence? What *biome* and geographic region is the location you chose situated? Is there empirical evidence for climate change within the biome you are investigating? How does the *biome* of your location influence your expected and obtained results? What *global systems* could have impacted the results you obtained? Create a potential *model* for the data by integrating multiple components of *global systems* to explain the trends you obtained, including:

- Biosphere components and interactions

- Climate (weather, adaptation, anecdotal versus scientific evidence)
- Energy relationships in the biosphere (insolation and angle of inclination/incidence, latitude, albedo, natural greenhouse effect, greenhouse gases, net radiation budget)
- Thermal energy transfer in the atmosphere & hydrosphere (radiation, conduction, convection, atmospheric pressure, Coriolis effect, global wind patterns, specific heat capacity, vaporization, biome influences of the particular location chosen)
- Changes in global energy transfer (evidence for climate change and changes in GHG concentrations, carbon sources and sinks, enhanced greenhouse effect, global warming, stabilizing GHG levels, potential impacts of climate change)

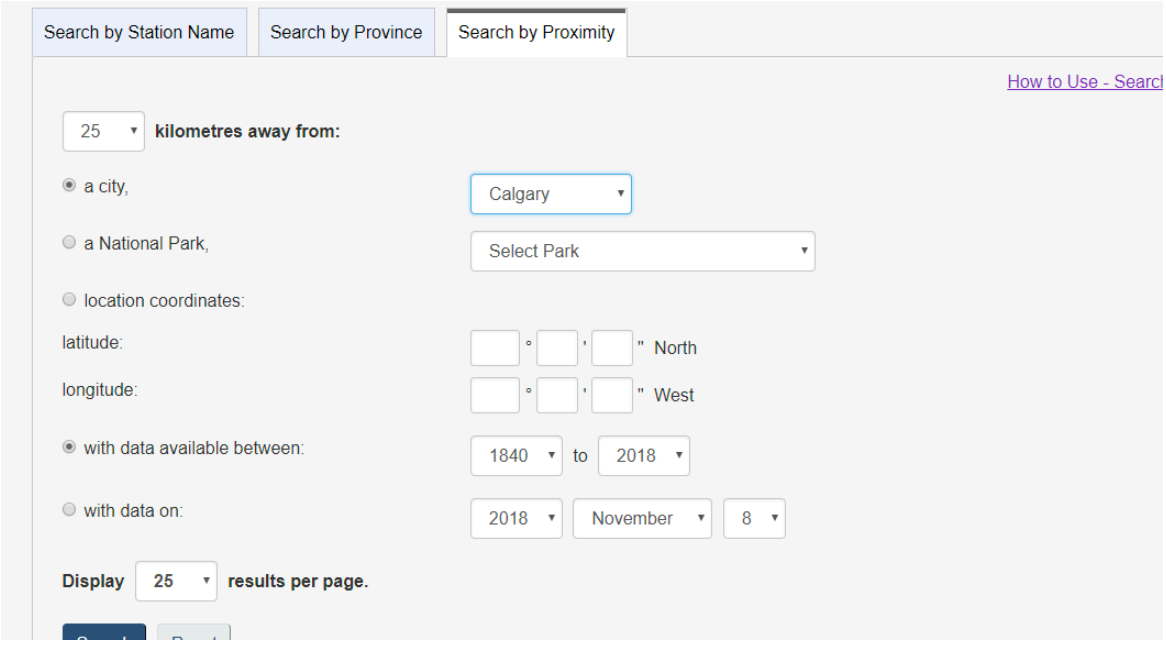
Compare the trends that you studied in your biome to another group that investigated a different biome at an alternate location.

Conclusion and Resources

Provide a brief conclusion for the results that you obtained. What are some additional questions you would want to investigate if you had more time to work on the inquiry project? Investigate different scientifically *robust* and reliable sources of evidence that support the conclusion you reached. How do you know which resources are reliable? Cite and reference the resources you utilized throughout your inquiry using APA (http://owll.massey.ac.nz/referencing/apa-style.php). Write a lab report (4-6 pages) for the investigation you conducted.

How to download your data from Environment Canada

1. Go to http://climate.weather.gc.ca/historical_data/search_historic_data_e.html
2. Search by city or area



3. Pick a station with enough data points to discern a trend (>50 year), select **monthly** data from 'data interval' dropdown

Station	Prov.	Prox. (km)	Data Interval	Year	Month	Day	
CALGARY GLENMORE DAM	AB	3.43	Daily	1979	Sep	30	Go
CALGARY NOSE HILL	AB	6.94	Daily	2012	Apr	29	Go
CALGARY ROSSCARROCK	AB	7.39	Daily	2012	Apr	25	Go
CALGARY MARLBOROUGH	AB	7.60	Daily	2012	Apr	28	Go
UNIVERSITY OF CALGARY	AB	8.02	Monthly	1990	Dec	1	Go
CALGARY INT'L A	AB	9.82	Daily	2012	Jul	11	Go
CALGARY POPLAR GARDENS	AB	10.12	Daily	2004	Dec	31	Go
CALGARY INT'L CS	AB	10.24	Hourly	2018	Nov	8	Go
CALGARY BELLEVIEW	AB	10.36	Daily	1966	Aug	31	Go

4. Download the monthly data in a CSV file:
    a. Click "Monthly Data" under "Related Data"

Monthly Data Report for 1990

UNIVERSITY OF CALGARY
ALBERTA

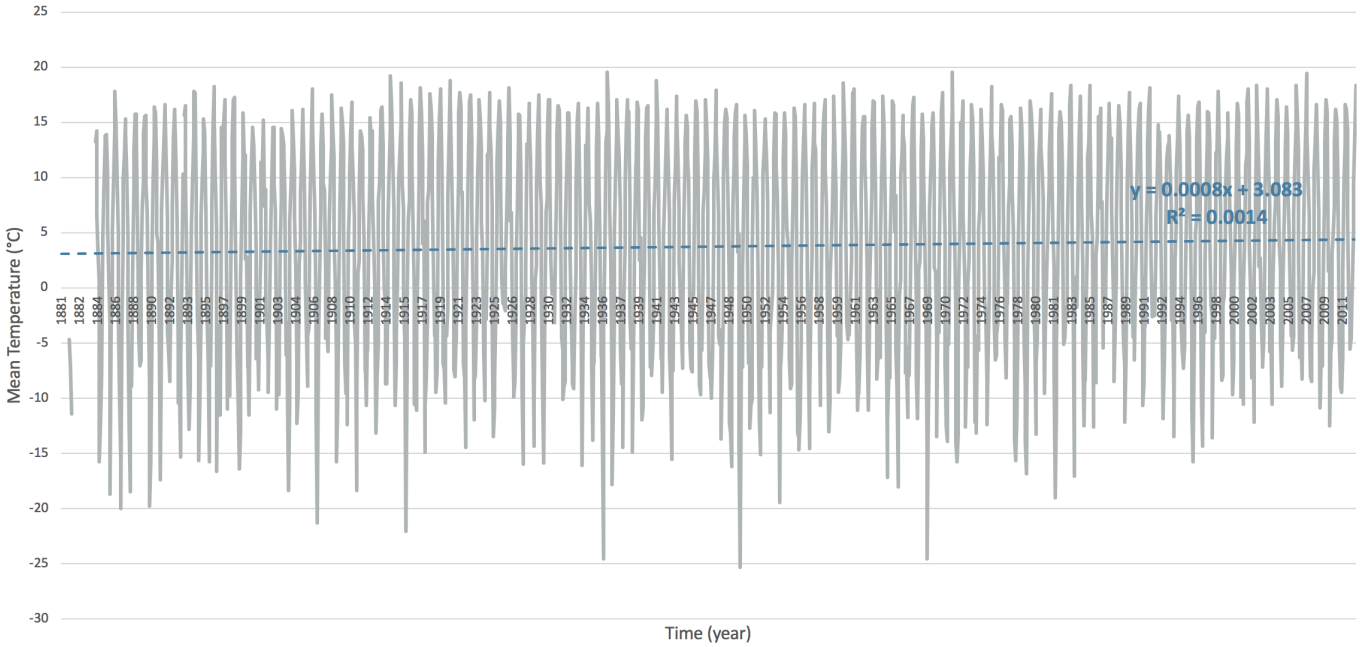
Latitude:	51°05'00.000" N	**Longitude**:	114°08'00.000" W	**Elevation**:	1,112.20 m
Climate ID:	3036652	**WMO ID**:		**TC ID**:	

Related Data	Additional Search Options	Download Data
No related data is available for this station	Nearby Stations with Data	Monthly Data (1964-1990)
	Historical Data Search	CSV XML
		Download Data
		Get More Data

5. Create a graph with the “Year” and “Mean Temp (°C)” data.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1	Station Nam	CALGARY INT'L A																		
2	Province	ALBERTA																		
3	Latitude	51.11																		
4	Longitude	-114.02																		
5	Elevation	1084.1																		
6	Climate Iden	3031093																		
7	WMO Identi	71877																		
8	TC Identifier	YYC																		
9																				
10	Legend																			
11	B	More than one occurrence and estimated																		
12	E	Estimated																		
13	M	Missing																		
14	S	More than one occurrence																		
15	T	Trace																		
16	[empty]	No data available																		
17	^	The value displayed is based on incomplete data																		
18																				
19	Date/Time	Year	Month	Mean Max T	Mean Max T	Mean Min T	Mean Min T	Mean Temp	Mean Temp	Extr Max Te	Extr Max Te	Extr Min Ter	Extr Min Ter	Total Rain (n	Total Rain Fl	Total Snow (c	Total Snow F	Total Precip	Total Precip	Snow Grnd L	Snow
20	1881-01	1881	1		M		M		M		M		M		M		M		M		
21	1881-02	1881	2		M		M		M		M		M		M		M		M		
22	1881-03	1881	3		M		M		M		M		M		M		M		M		
23	1881-04	1881	4		M		M		M		M		M		M		M		M		
24	1881-05	1881	5		M		M		M		M		M		M		M		M		
25	1881-06	1881	6		M		M		M		M		M		M		M		M		
26	1881-07	1881	7		M		M		M		M		M		M		M		M		
27	1881-08	1881	8		M		M		M		M		M		M		M		M		
28	1881-09	1881	9		M		M		M		M		M		M		M		M		
29	1881-10	1881	10		M		M		M		M		M		M		M		M		
30	1881-11	1881	11	1.3		-10.6		-4.7		12.2	S	-27.2		0	T	10.2		10.2			
31	1881-12	1881	12	0.4		-14.8		-7.2		12.8		-30.6		0		9.1		9.1			
32	1882-01	1882	1	-4.1		-18.6		-11.4						0		18		18			
33	1882-02	1882	2		M		M		M						M		M		M		
34	1882-03	1882	3	-1.3		-14.9		-8.1						0		30		30			
35	1882-04	1882	4		M		M		M						M		M		M		
36	1882-05	1882	5		M		M		M						M		M		M		
37	1882-06	1882	6	20.8		7.4		14.1							M		M		M		
38	1882-07	1882	7		M		M		M						M		M		M		
39	1882-08	1882	8		M		M		M						M		M		M		
40	1882-09	1882	9		M		M		M						M		M		M		

Mean Temperature (°C) versus Time (year) for Calgary (international airport station) between 1881-2012



Plot your data on a temperature vs time graph. Add a trend line and analyze what the graph is telling you.

Grading

E = Exceptional
C = Commendable
M = Meets Expectations
N = Not Meeting Expectations

Rubric

Criteria	N (0-25%)	M (25-50%)	C (50-75%)	E (75-100%)
Formulates or reformulates a vital problem, question or issue.	Fails to identify or summarize a problem, question or issue.	Summarizes a problem, question or issue. Some aspects are confused, and key details are missing or overlooked.	Clearly and precisely formulates or reformulates the vital aspects of a problem, question or issue as it relates to the context.	Vital aspects of the problem, question or issues are clearly and precisely formulated or reformulated identifying integral relationships essential to analyzing the problem, question or issue as it relates to the context.
Gathers, assesses and analyzes relevant information, data and robust evidence.	Information, data or evidence are simplistic, or unrelated to the problem, question. Information or data are repeated without question and evidence is dismissed without adequate justification. References not provided.	Appropriate information, data or evidence is provided. Information or data are selective but largely unexamined in terms of accuracy, relevance and completeness. Provided vague references about sources of information.	Appropriate information, data or evidence is provided and are thorough, fully analyzed and reported. Information, data or evidence and its source is questioned in terms of accuracy, relevance and completeness.	Information, data or evidence gathered are extensive, furthering insight into the problem, question or issue. Information, data or evidence and its sources are fully analyzed and evaluated as to accuracy, reliability and relevance. Variables

			Attempted referencing using APA.	are effectively compared using clear graphical trend. Referenced properly using APA.
Arrives at well-reasoned interpretations & conclusions.	Provides a simplistic interpretation & conclusion with no consideration of implications	Demonstrates and presents simplistic interpretations & conclusions. Basic discussion of implications.	Exemplifies: • plausible interpretation • consideration of assumptions • reasoned judgment and • conclusions based on evidence, and • consideration of implications that reach beyond the immediate situation	Exemplifies: • plausible, coherent working theories, • well-reasoned judgment and conclusions based on evidence with an examination of different viewpoints, and, • an analysis of assumptions, • a thorough examination of implications • compares biome analyzed to alternate group to provide increased depth of investigation
Integrates global systems concepts to help explain findings	Minimal integration of concepts from the global systems unit into analysis and interpretation.	Integrates some components of global system into analysis and interpretation but relationship to data set is marginally developed.	Integrates multiple concepts from the global system unit and begins to relate concepts to analysis and interpretation provided.	Integration a wide range of concepts from unit, in a novel way, to provide a multifaceted explanation (support or oppose) of results obtained. Provides a

				holistic understanding of global systems by integrating multiple topics to interpret data and trends.
Communication and teamwork	Works alone to answer questions related to the topic under consideration.	Shares ideas with others related to the topic under consideration to build collective understanding of the topic.	Interacts with others in figuring out complexities related to the ideas of the topic under consideration.	Synthesizes data using multiple interpretations of evidence. Builds coherently on ideas to promote improved collective understanding of a topic.

(Adapted from Galileo Guide to Assessing Critical Thinking, 2008)