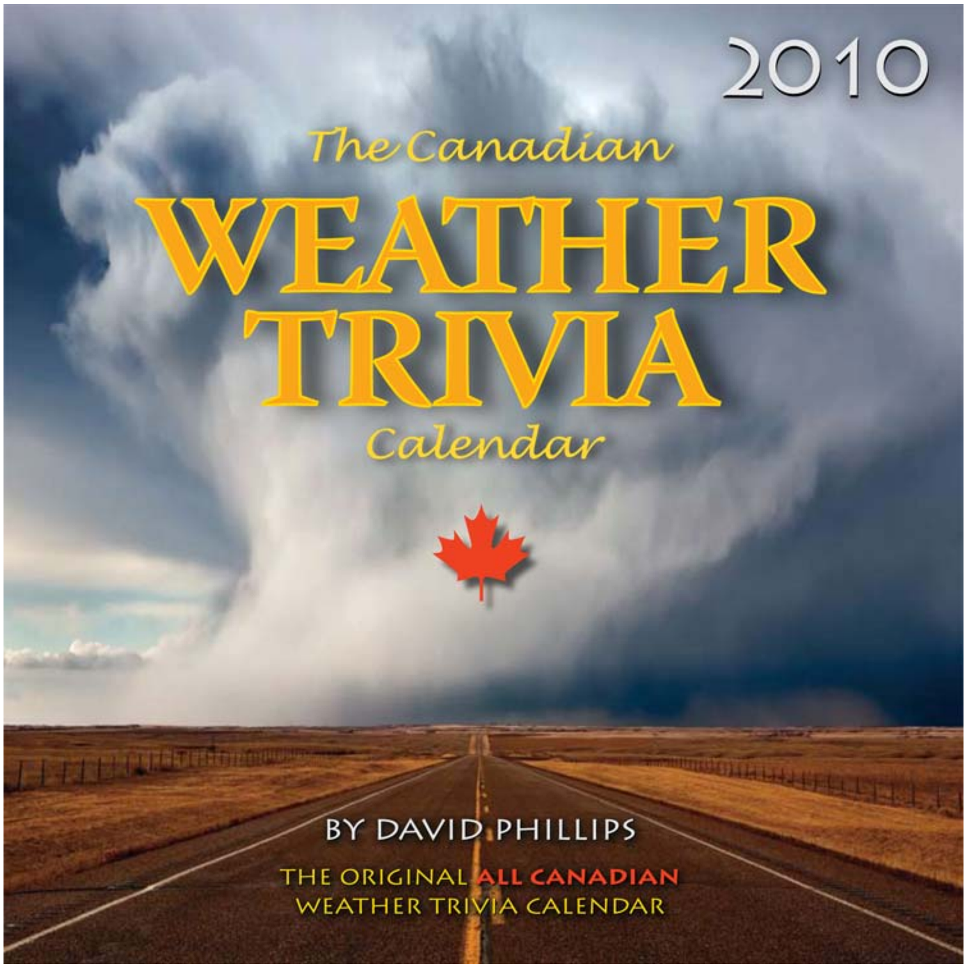

Teacher's Guide

A free, downloadable guide to *The 2010 Canadian Weather Trivia Calendar* available at www.fitzhenry.ca

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FIFTH HOUSE

Teacher’s Guide
The 2010 Canadian Weather Trivia Calendar

The Calendar

Whining, griping, and carping about the weather is good for you.

A psychologist with Clemson University in South Carolina says that complaining about the weather can be good for you if it is strategic, ie., not chronic but occasional. As always, there’s lots to complain about in the weather of *The 2010 Canadian Weather Trivia Calendar*, as well as lots to celebrate and plenty to amaze you. This twenty-second edition of the calendar by Canada’s weather wizard, David Phillips, brings you a whole year of new and fascinating weather information.

The author, David Phillips

Environment Canada senior climatologist David Phillips has been called “a genuine Canadian legend” and “our unofficial weather guru,” but prefers to think of himself as Canada’s weather ambassador. He has been studying Canadian climates and promoting the importance of weather and climate in this country for forty years.

The Teacher’s Guide

The Canadian Weather Trivia Calendar Teacher’s Guide 2010 is an instructor resource that correlates to *The Canadian Weather Trivia Calendar 2010*. Offering four distinct components—activities, discussion questions, self-directed research, and “Time to Reflect” segments—this guide can be used individually or as a series of lessons, depending on the requirements of the teacher. Some activities have an added dimension, “Extending the Exercise,” in which teachers can choose to continue with the activity in question with further discussion or student research. The activities in this guide are drawn from the Earth Sciences curriculum shared by Canada’s provinces and territories for grades five to eight.

Activity One: Make Lightning!

Calendar Connection
There are many different calendar entries that deal with lightning. For example, the entries for April 22; June 2, 12, 23; July 2, 8, 27; August 3, 5, 11, 13; September 1, 4, 24; and October 8 all describe the damage and injury that can result from lightning. The entry for May 14 contains a Weather Quiz question on lightning. Even though it can be dangerous, lightning is also an amazing and wonderful sight, as shown by September's photo in the calendar.

Objective
With this activity, students will discover that lightning is all about static electricity. The mini spark they create with their finger and the pie pan mimics a mini bolt of lightning. This activity can be performed by groups of students.

Backgrounder
Discuss with students what they see when they view lightning in the sky and then explain what causes it. Lightning is an electric current causing bright flashes of light that is produced by a thunderstorm. All thunderstorms produce lightning.

Lightning happens when the negative charges (electrons) in the bottom of a thundercloud are attracted to the positive charges on the ground. Thunderclouds contain many small bits of ice (frozen raindrops) that bump into each other, creating an electric charge. The clouds fill up with electric charges, the positive charges (protons) forming at the tops of the clouds, the negative charges (electrons) forming at the bottoms of the clouds. Since opposites attract, positive changes build up on the ground underneath the clouds, concentrating around vertical features, such as mountains, people, and stands of trees. As electric charges accumulate, they overcome the insulating properties of air until a stream of electrons from the bottoms of the clouds meets the protons building up from the ground. A connection is made and at that point lightning occurs.

Materials Required
For each group of students:
- Styrofoam plate
- thumbtack
- pencil with new eraser
- aluminum pie pan
- small piece of wool fabric

Procedure
1. Push the thumbtack through the centre of the aluminum pie pan from the bottom.
2. Push the eraser-end of the pencil into the thumbtack.

3. Put the Styrofoam plate upside-down on a table. Taking the small piece of wool fabric, quickly rub the bottom of the plate for a couple of minutes.
4. Pick up the aluminum pie pan using the pencil as a handle and place it on top of the upside-down Styrofoam plate.
5. Touch the pie pan with your finger. You should feel a tiny electric shock. If you do not feel anything, try rubbing the Styrofoam plate again with the wool fabric.
6. Once you feel a shock, rub the plate again and this time turn out the lights in the classroom before you touch the pan. You should be able to see a tiny spark.

Extending the Exercise

Ask the students to research the answers to the following questions:

1. How hot is lightning?
2. What colour is lightning?
3. How do you know if lightning is nearby?
4. What is the difference between ball lightning and sheet lightning?
5. What causes thunder? Does it have anything to do with lightning?

Self-directed Research

One of the most well-known experiments having to do with lightning was conducted by American inventor Benjamin Franklin using a kite. Have students research and write a short report about this experiment. Have them think about the following questions:

1. What did Franklin prove with his experiment?
2. Franklin did not "invent" electricity, but he did invent something that would end up protecting buildings and ships from lightning damage. What was it? (Hint: One of the stories featured in the "Great White North, Eh?" mentions the answer to this question.)
3. Did Franklin even conduct the experiment as told by the popular story? Some scientists argue, no. What are their reasons for saying so?

Activity Two: Fog in a Bottle

Calendar Connection

Dense fog can be difficult, if not impossible, to see through. Many of the calendar entries describe obscuring fog that has delayed boat, car, and air traffic, and precipitated accidents that have caused injuries and death. Examples include December 9, 15; January 7, 20, 22, 30; October 11, 23; November 9, 16; April 9; and March 30. Like so many weather phenomena that are potentially dangerous, fog is also very beautiful, as shown in the calendar photo of the Lion's Gate Bridge for January. Then there are fog's lesser known uses, such as a getaway aid for armed robbers! (For this last example, see the calendar entry for December 5).

Objective

With this activity, students will learn how radiation fog (sometimes also called ground fog) is formed. The hot water in the glass bottle heats the air just above it. The ice cube creates a layer of cool air just above the warm air. Fog forms when the cool air below the ice meets the warm air above the hot water. This activity can be performed by groups of students.

Backgrounder

Radiation fog is formed on clear still nights, most commonly in autumn and early winter, when the ground loses heat by radiation and cools. As the ground cools, the warm moist air above the ground cools quickly, condensing into small water droplets that we see as fog. Once dawn breaks, fog tends to disperse as it is "burned off" by solar radiation. Solar radiation penetrates the fog and heats up the ground and the layer of air near it. The air eventually warms up enough so that the water droplets evaporate.

Materials Required

For each group of students:

- glass bottle with a narrow enough neck that you can stick an ice cube completely over the bottle's mouth
- hot water (it does not need to be boiling)
- rubbing alcohol
- ice cube

Procedure

1. Fill the bottle 1/3 full with very hot water.
2. Add a few drops of rubbing alcohol.
3. Place the ice cube over the mouth of the bottle.
4. Watch the fog develop!

Extending the Exercise

Ask the students to research the answers to the following questions:

1. What is the difference between radiation fog and advection fog? Where does advection fog most commonly occur?
2. The calendar photo for January shows the Lion's Gate Bridge in Vancouver, BC, covered in fog. What kind of fog is pictured here?

Time to Reflect: Fog vs. Smog

Although the words sound similar when you say them out loud, smog is very different from fog. Smog is a type of air pollution caused by human activities, particularly the burning, or combustion, of fossil fuels. It is mainly made up of ground-level ozone. Ground-level ozone is produced by sunlight acting on hydrocarbon and nitrogen oxide gases. Smog also contains fine particulate matter, which is a mix of solid particles and liquid droplets in the air. Particulate matter includes things like aerosols, smoke, and dust. Different industries burn enormous amounts of fossil fuels, but we also burn fossil fuels when we do everyday things like drive our cars and heat our homes.

Smog damages agricultural crops and natural habitats throughout the world. It also has negative effects on our health. It causes headaches and breathing difficulties and can place some people, especially children, the elderly, and people with diseases like asthma, at serious risk.

1. As citizens of the world, discuss with students what they can do in their own lives, communities, and homes to reduce the pollutants that cause smog.
2. Discuss the difference between non-renewable and renewable energy sources with students. List examples of each kind (e.g., coal, oil and natural gas, and nuclear power vs. wind power, solar power, and hydropower). Explain the concept of sustainability and then discuss which type of energy source best meets the goals of sustainability.[1]

[1] Sustainability refers to the ability of an ecosystem to sustain ecological processes and maintain biodiversity over time. It also refers to using natural resources in a way that maintains ecosystem health now and for future generations.

Activity Three: Pinecone Hygrometer

Calendar Connection

Humidity is mentioned in two calendar entries: September 9, which includes a Weather Quiz question; and October 23. Regardless of its relative low profile in this volume of the calendar, humidity is a very important part of weather. During the summer, we all feel the effects of humidity. This is especially true if you live in the southern regions of Ontario, Manitoba, and Quebec!

Objective

With this activity, students will use pinecones to create a hygrometer, which is an instrument that measures humidity, or the degree of moisture in the air. In dry air, pinecones open their scales to disperse their seeds, while in damp, moist air they close them to protect their seeds. This activity can be performed by groups of students.

Backgrounder

Humidity is the degree of moisture in the air. Relative humidity is the amount of moisture that the air contains compared to the maximum it can hold at a given temperature. For example, if relative humidity is at 100%, this means the air has become saturated and that mist, fog, dew, or precipitation are likely.

A hot and humid day is much more uncomfortable than a drier but equally warm day. The human body tries to maintain a constant internal temperature of 37°C at all times. In hot weather, our bodies produce sweat, which cools the body as it evaporates. However, as the humidity in the air increases, sweat has a harder time evaporating. When relative humidity reaches about 90%, sweat stops evaporating. On a hot and humid day like this, our body temperatures rise and some people may even become ill.

Materials Required

For each group of students:

- spray bottle
- water
- masking tape
- lump of Plasticine
- pinecones (4 per group); preferably with scales that are open, long, and relatively lightweight (these types of cones are more sensitive to humidity)
- wide-mouth jars with lids (4 per group); jars must be taller and wider than the pinecones

Procedure

1. Divide your lump of Plasticine into four pieces. Put one piece in the bottom of each jar. Attach the base of each pinecone to the Plasticine at the bottom of each jar, so you have four pinecones in four jars.
2. Use the spray bottle to mist the pinecones inside the jars. Then, tightly fasten the jar lids onto the jars, and turn them upside-down.
3. Monitor the pinecones for the next few hours. Write your observations using a table like the one below:

Jar #	Number of minutes to close pinecone scales
1	
2	
3	
4	

4. Once each pinecone has closed, open its jar. Leave all of the jars open over night. The next day, write down your findings by answering the following questions:
    a. What happened to the pinecones after you left the jars open all night? Did the pinecones' scales stay closed or did they reopen?
    b. Depending on whether the pinecones' scales stayed closed or reopened, what does that tell you about the humidity in your classroom?
5. Once all four pinecones have dried out completely, fill one jar cap with water. Turn one of the jars upside-down and screw it onto the lid. Be sure the pinecone does not touch the water. Leaving a second jar cap dry, screw it on to another of the jars. Seal both with tape. These two jars will serve as the control. Place the two jars in a cool, dark place.
6. Repeat Step 5 with the remaining two cones, but place these jars in a sunny window. Wait a few hours and then observe and compare these jars against the control jars. Record your findings by answering the following questions:
    a. What difference, if any, do you see between the control jars and the jars in the sunny window after a few hours?
    b. Is there condensation on the sides of any of the jars?
    c. What do your observations between the two sets of jars tell you about the humidity of a cool, dark place compared to the humidity in a sunny window?

Extending the Exercise

The humidex is a Canadian innovation, first used in 1965. It was created by Canadian meteorologists to describe how hot, humid weather feels to the average person. The humidex combines the temperature and humidity into one number to reflect the perceived temperature. Ask the students to research the answers to the following questions about the humidex:

1. What are the different humidex ranges and corresponding degrees of comfort?

2. Does the humidex have any limitations that affect its accuracy? If so, what are they?
3. What location in Canada holds the record for the highest humidex reading? (Hint: The answer can be found listed in the calendar's "All-Time Canadian Weather Extremes.")

Self-directed Research

Ask students to invent their own hygrometer, complete with a drawing and written explanation of how it works to measure humidity. Help them think of ideas by asking them to think of any other plants or substances that respond clearly to changes in humidity that could be used similar to the way the pinecones were used in the activity.

[*Some students may think of hair as a material that could be used as a hygrometer, but it has already been invented! Hair length actually increases with humidity. The range between dry and saturated air can account for a difference in hair length of about 3% (this is why in humid weather, curly-haired people get the "frizzies" and straight-haired people's hair goes limp). Because of the way it responds to humidity, hair was used as the primary element in the hair hygrometer. It was invented in 1783 and was used until more sophisticated technology came along in the 1960s.]

Activity Four: Volcanoes and Climate Change

Calendar Connection

Only two calendar entries refer to volcanoes: December 27 and June 5. June 5 refers to the cataclysmic eruption of Tambora Volcano in Indonesia in April 1815 and how Tambora's volcanic cloud lowered global temperatures by as much as 3°C. Even a year later in 1816, most of the northern hemisphere experienced cooler temperatures during the summer months, hence "the year without summer."

June 5 also marks World Environment Day. Volcanoes are a fitting subject for this date because although they are geological phenomenon, global cooling has been linked with major volcanic eruptions. This has prodded scientists to think about how volcanoes could be used to alter climate change (see Time to Reflect: "Manmade" Volcanoes, Geo-Engineering, and Climate Change at the end of this activity).

Objective

With this activity, students will learn how magma moves below Earth's surface before erupting as lava. Students will learn that magma leaves underground reservoirs through fractures in the surrounding rock. Learning more about volcanoes will provide students with background when it comes to learning that volcanoes are linked to global cooling. This activity can be performed by individual students or by groups of students.

Backgrounder

Magma is the molten rock, along with crystals and dissolved gases, found deep inside Earth's core. When magma erupts onto Earth's surface, it is called lava. When lava erupts, it makes distinct landforms, including lava plains and volcanoes, depending on how it erupts. A volcano is most commonly a conical hill or mountain built around a vent that connects to these reservoirs of magma. The term "volcano" also refers to the opening through which lava and gases are expelled. As magma rises, pressure builds, sometimes causing tremendous volcanic eruptions that spew lava and dense clouds of ash-laden gas.

How does magma move up from its underground reservoirs called magma chambers to erupt as lava on Earth's surface? Rather than moving through mapped out tunnels, magma moves through fractures in the surrounding rock. The fractures may be pre-existing or they may be created by the erupting magma itself. An active dike is a body of magma moving through a fracture that can be horizontal or vertical.

It turns out volcanic activity and climate are related. The calendar entry for June 5 provides an example of volcanism throwing airborne volcanic material into the stratosphere, creating a dust veil that lowers surface temperatures, providing a widespread cooling effect. Temperatures are lowered because the volcanic dust particles block some of the solar energy reaching Earth's surface. These dust particles are sulphur-based and are known as "aerosols."

Materials Required

For each student, or each group of students:

- single-serving cup of gelatin (e.g., Jell-O gelatin cups); you want a gelatin cup that is easy to see through, so the lighter the colour the better (e.g., lemon, orange flavour); the gelatin cups serve as transparent models of volcanoes
- pipette or eyedropper (a syringe also will work)
- push pin
- knife or pair of scissors
- food colouring; recommended colours are red, blue, or green; the food colouring acts as the dike-forming magma
- plenty of napkins
- a spoon

Procedure

1. Make sure your gelatin has been refrigerated and is nice and firm.
2. Make one or more holes in the base of the gelatin cup. Start each hole by first making a small hole with a push pin and then enlarge the hole using a knife or scissors. Make each hole just wide enough to allow the pipette or eyedropper to be inserted into it.
3. Prepare you food colouring (i.e., magma). Make sure your solution has a deep rich colour.
4. Fill the chamber of the pipette or eyedropper with your "magma." Try to get rid of as much air in the chamber as possible.
5. Insert the pipette or eyedropper into one of the holes at the base of the gelatin cup. Try not to insert it too far into the gelatin. If condensation develops on the sides of the gelatin cup, wipe the sides with a napkin.
6. Squeeze the "magma" contents into the gelatin. Repeat for the other holes.
7. Watch what happens to the food colouring as it is squirted into the gelatin. Like real magma, your "magma" leaves its underground reservoir and moves through fractures in the surrounding rock.
8. You could also try repeating this activity by injecting your cup of gelatin with pudding … learning has never tasted so good!

Extending the Exercise

Like the Tambora eruption in 1815, other major volcanic eruptions have occurred. Have the students research the following eruptions, and report on their effects, if any, on climate, and how widespread these effects were, or continue to be.

- Mount St. Helens, USA, May 1980
- Mount Hekla, Iceland, August 1980

- Mount Pinatubo, Philippines, June 1991

Time to Reflect: "Manmade" Volcanoes, Geo-Engineering, and Climate Change

The world's countries continue to negotiate how they will reduce their carbon dioxide emissions from the burning of fossil fuels (e.g., the recent UN-sponsored climate change talks in Copenhagen in December 2009). Meanwhile, some scientists and scientific organizations, such as the UK's Royal Society, have announced they are supporting research on "manmade" or simulated volcanic eruptions as a way to counteract global warming. The simulated volcanic eruptions would shoot tonnes of sulphur-based particles into the stratosphere to reflect solar energy back into space, thereby cooling Earth's temperatures. The simulated volcanic eruptions would form part of geo-engineering: the manipulation of Earth's climate to counteract global warming.

Scientists who support geo-engineering argue that humans generate too much carbon dioxide and that even if cuts to greenhouse gas emissions are made, it will be too little too late. They feel geo-engineering is the only effective way to prevent drastic and destructive climate change.

Ask students to research other examples of geo-engineering (e.g., mirrors in space to reflect sunlight away from Earth's surface; blocking sunlight reaching Earth with cloud-whitening; using giant artificial nuclear-power-driven filters to chemically strip carbon dioxide from the air). Then discuss how viable these ideas are, exploring the costs and benefits, how they would potentially affect the planet in other ways, and how long each would take to actually make a dent in atmospheric carbon dioxide.