



## Lesson Plan

### The Climate Challenge Game



#### In a Nutshell:

Through a television-style quiz challenge, students learn about the basics, impacts, and solutions to global climate change in a fun, informative manner. This multi-part quiz can be used as an introduction to climate change, as a culmination of a climate change unit, or in sections during a climate change unit to interest and motivate students.



#### Goal:

To help students gain a better understanding of climate change, its impacts, and the solutions – global, local, and personal – to climate change.



#### Background Learning:

**Teachers** should be familiar with the basic science of climate change and its anticipated impacts as reviewed in:

- High School Backgrounder #1: Climate Change: What's the Big Deal?
- High School Backgrounder #2: The Greenhouse Effect

Also useful are these backgrounders on solutions:

- High School Backgrounder #13: Renewable Energy Opportunities
- High School Backgrounder #14: Helping in your own way
- High School Backgrounder #15: What Schools can do!
- High School Backgrounder #17: Governments and Businesses: Walking the Talk

**Grade Level:** Grades 8–12

**Subjects:** Social Studies, Geography, Sciences, English Language Arts, Northern Studies

**Enrichment:** Social Studies, Geography, Sciences, English Language Arts

**Time:** One to two hours

**Setting:** Classroom

**Materials:** Paper, pens

**Skills:** Analysis, discussion, small group work, problem solving, inference, description, concept development

#### Key Vocabulary:

Greenhouse gases, fossil fuels, carbon dioxide, climate change, methane, atmosphere, small-scale hydro, biodiesel, ground-source heat, solar power



If this is the only lesson you are doing on climate change, your **students** should read:

- High School Backgrounder #1: Climate Change: What's the Big Deal?

## Learning Outcomes:

Visit the website and click on the icon for your territory to review the learning outcomes that are addressed by this lesson.



Nunavut



NWT



Yukon



## Introduction to Lesson Plan:

This lesson is set up as a Quiz Game, following a pattern that students may have seen on TV. It runs through five rounds:

- Round 1: Climate Change Basics
- Round 2: Impacts
- Round 3: Solutions – Global
- Round 4: Solutions – Local
- Round 5: Solutions – Personal

The main components of the game are contained in the teacher handouts.

Read the rules prior to starting this game. They are available as the activity outline for the lesson and as a Teacher Handout. – Climate Challenge Quiz Rules – that can be accessed through the handout section of this lesson.

Once you understand the game you can decide how you will structure the quiz for your particular class needs. You will need to consider your timing – whether you will do it all at one time, or spread the rounds over several classes. You will need to consider how you will be dividing the class into groups so they all get a turn in the different rounds. For Question 6b in Round 5 of the Quiz, you will need to adapt the question and the answer to show the actual cost of electricity per kWh in your community. You will find the cost on your electricity bill.



## Activity:

### Pre-lesson Teacher Preparation:

For Question 6b in Round 5 of the Quiz, you will need to adapt the question and the answer to show the actual cost of electricity per kW.h in your community. You will find the cost on your electricity bill.

Read the rules (Teacher Handout – Climate Challenge Quiz Rules), and decide how you will structure the quiz: timing (whether you will do it all at one time, or spread the rounds over several classes), dividing the class into groups to take turns in the different rounds, etc.

Explain the rules to the class.

1. There are five rounds in this game, with 10 or more questions in each round. The quizmaster (generally the teacher) has the correct answers, and should be able to explain them, answer follow-up student questions and lead the discussion. The quizmaster keeps score on the blackboard.
2. Ask two students are asked to act as referees for each round. In the event of a close call, their job is to decide which team called out their answer first. They can also participate in the game.
3. Each round is played by two teams of three members each, who sit in front of the class. Both teams need pens and paper, to make notes. (Each round has six people in two teams, allowing 24 students to participate over the four rounds. If there are less than 24, use whatever means you like to make up the team numbers. If there are more than 24, the teams should be larger.)
4. Have each team choose a name, and a word or noise that they will call out to indicate when they are ready with an answer. The class as a whole can choose how to congratulate the winning team.
  - Round 1 (Climate Change) has 10 questions, and three bonus questions
  - Round 2 (Impacts) has 11 questions.
  - Round 3 (Global Solutions) has 16 questions.
  - Round 4 (Local Solutions) has 12 questions.
  - Round 5 (Personal Solutions) has 21 questions.





- 5. Have every student who is not on a team take a piece of paper, and draw three columns, to track their own score:

Question	Answer	Points
<b>Total</b>		

Each time a question is asked, everyone who is not on a team writes their own answer in Column two, and keeps score of their results. At the end of each round, they add up their scores to see who has the highest.

- 6. Each time a question is asked, the team members discuss it, and agree on their answer. As soon as they are ready, they call out their word or noise. As the Quizmaster, you ask them the question. If they are correct, they win the points associated with the question. If they are wrong, the other team is given 10 seconds to answer the same question.
- 7. If both teams get the answer wrong, the question goes to the class. The first student who answers the question correctly wins the points for that question. He or she also has a chance to explain why that is the correct answer. If he or she can do this to the satisfaction of the Quizmaster, he or she wins twice the



value of the points for that question. After any question, the Quizmaster may ask any student who is not in a team to volunteer to explain why this is the correct answer. A good answer earns 10 bonus points; a middling answer earns five bonus points. A disruptive answer loses five points.

8. As Quizmaster, you may arbitrarily increase the points that can be won for the final three questions to encourage the team that is behind.
9. After each Round, the points are tallied up, and the winning team is announced. The students who are not in a team also add up their points, and the Quizmaster invites anyone to call out a score, to see who has won. The two winning students are invited to head up the next two teams, based on the birth dates of other students closest them. Each student can only join a team once.
10. Play the Climate Challenge Game, in five rounds. Make sure the game becomes a real learning experience, by pausing after each question to explain the answer and/or after each round to discuss the topic.



### Handouts:

Visit the website and click on the icon for the complete set of handouts that support this lesson:

- Teacher Handout – Climate Challenge Quiz Rules
- Teacher Handout – Round 1: Climate Change Basics
- Teacher Handout – Round 2: Impacts
- Teacher Handout – Round 3: Solutions – Global
- Teacher Handout – Round 4: Solutions – Local
- Teacher Handout – Round 5: Solutions – Personal



### Student Web-Exchange:

Post some or all of the student reports suggested in the evaluation and enrichment sections of this lesson. Visit the website and click on the icon for information on how to post material.



### Evaluation:

- Ask each student to write down the five most important or most interesting new facts or pieces of information that they learned during the class, and to include these in a short report. One or more of these could be selected to post on the Student Web-Exchange.
- Create a short paper-and-pencil quiz, based on some of the questions discussed in class.



### Enrichment Ideas:

#### Geography, Social Studies, Biology, Science, Environmental Studies

**Extend the Challenge:** Make this a team challenge between two classes, who prepare for it first through reading the backgrounders, and additional research.

#### Social Studies, Science, English Language Arts

**Expand the Quiz:** Invite students – working either individually or in small groups – to create questions (along with the answer and explanation) for another Climate Challenge Quiz, to be used in your class, or for other classes.



### More Information:

Most of the material in this Quiz has been gathered from *Stormy Weather: 101 Solutions to Global Climate Change*, by Guy Dauncey. The book is arranged in easy two-page units, and includes addresses for 1300 websites. For purchase details, see [www.earthfuture.com/stormyweather](http://www.earthfuture.com/stormyweather) and [www.amazon.ca/exec/obidos/ASIN/0865714215/701-6276568-5579527](http://www.amazon.ca/exec/obidos/ASIN/0865714215/701-6276568-5579527)



## Geography, Social Studies, Biology, Science, Environmental Studies

**Planning for Change:** Invite the students to do one of the following, based on the information that they have gathered from the quiz and elsewhere:

- develop a plan to reduce the school's greenhouse gas emissions
- design a house that would produce very few greenhouse gas emissions
- design a small community that would produce very few greenhouse gas emissions



### About the Author:

#### Guy Dauncey

I live with my wife and various animals on a small organic plant nursery, just outside Victoria, on Vancouver Island.

I work as an author and consultant in the fields of global climate change, sustainable energy policy, green buildings, and green communities. I am author of the book *Stormy Weather: 101 Solutions to Global Climate Change* (New Society Publishers, 2001, \$27.95), and a frequent public speaker and workshop leader.

In 2001, I helped draft the Whitehorse Declaration on Northern Climate Change at the Circumpolar Climate Change Summit. I have yet to travel north of Whitehorse, but I have been following the impact of global climate change on the Arctic for many years, with growing concern.

My website is [www.earthfuture.com](http://www.earthfuture.com).





# Teacher Handout

## The Climate Challenge Game Rules

The game is based on the TV show *College Bowl (University Challenge)*.

### The Rules:

1. There are five rounds in this game, with 10 or more questions in each round. The quizmaster (generally the teacher) has the correct answers, and should be able to explain them, and answer follow-up questions, and lead the discussion. The quizmaster keeps score for the competing teams on the blackboard.
2. Two students are asked to act as referees for each round. In the event of a close call, their job is to decide which team called out their answer first. They can also participate in the game by keeping track of their own answers and scores (see 5 below).
3. Each round is played by two teams of three members each, who sit in front of the class. Both teams need pens and paper, to make notes. (Each round has six people in two teams, allowing 24 students to participate over the four rounds. If there are less than 24, use whatever means you like to make up the team numbers. If there are more than 24, the teams should be larger.)
4. Each team chooses a name, and a word or noise that they will call out to indicate when they are ready with an answer. The class as a whole can choose how to congratulate the winning team.
  - Round 1 (Climate Change) has 10 questions, and three bonus questions
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8. As Quizmaster, you may arbitrarily increase the points that can be won for the final three questions to encourage the team that is behind.
9. After each Round, the points are tallied up, and the winning team is announced. The students who are not in a team also add up their points, and the Quizmaster invites anyone to call out a score, to see who has won. The two winning students are invited to head up the next two teams, based on the birthdates of other students closest them. Each student can only join a team once.



# Teacher Handout

## The Climate Challenge Game

### Round 1: Understanding Climate Change

**QU. 1 (5 points).** What warms the Earth, so that humans, animals and plants can live on it?

- (a) Heat from the Earth's molten core
- (b) Heat from the Sun
- (c) Heat from the stars in the galaxy
- (d) Heat from baked beans

**Answer:** (b) Heat from the Sun.

The molten core of the earth radiates a tiny amount of heat upwards, but not enough to warm anything, except in hot springs. The stars produce such a tiny fragment of heat that it's not even really measurable. Baked beans could produce secondary heat, if the methane gas that sometimes results from their consumption was trapped and burnt, but they have to be grown first.

**QU. 2 (10 points).** What does the Earth's atmosphere do?

- (a) It traps heat from the sun, keeping life on Earth warm
- (b) It allows light to reach the Earth, enabling photosynthesis to take place
- (c) It assists gravity with atmospheric pressure, making things heavy, to stop them floating away
- (d) It allows Earth to receive cosmic rays and signals from other stars

**Answer:** (a) It traps heat from the sun, keeping life on Earth warm.



**QU. 3 (10 points). What would happen if Earth did not have an atmosphere?**

- (a) Everyone would die from the heat of the sun
- (b) Everyone would freeze from the cold of the night
- (c) Humans would never have evolved
- (d) The Earth would have been destroyed by asteroids

**Answer:** (c) Humans would never have evolved.

Answers (a) and (b) might be correct if the atmosphere was suddenly removed today, but there is no sign that anything might do this.

Answer (d) is a risk, but not a certainty.

Answer (c) is a certainty, so wins the point.

**QU. 4 (10 points). What is a greenhouse gas?**

- (a) A gas that is part of the ozone layer that protects the Earth against harmful rays from space
- (b) A gas that comes from cars, trucks and planes, causing smog and air pollution
- (c) A gas that is used to make tomatoes grow faster in a greenhouse
- (d) A gas that traps the Earth's heat, after it has arrived from the Sun

**Answer:** (d) A gas that traps the Earth's heat, after it has arrived from the Sun

Ozone depletion is a separate problem, caused by chlorine based gases (CFCs and HCFCs), and has only a distant connection to global climate change

Smog and pollution are also caused by burning fossil fuels, but it's the carbon dioxide that is the greenhouse gas. On its own, CO<sub>2</sub> does not cause smog or local air pollution

**QU. 5 (10 points). Which of these planets has the strongest greenhouse effect?**

- (a) Earth
- (b) Mars
- (c) Venus
- (d) Jupiter

**Answer:** (c) Venus



**Bonus Points (2 points each):**

1. Do you know how hot it is on Venus, which has a very strong greenhouse effect?

2. Do you know how cold it is on Mars at night, which has no greenhouse effect?

**Answers:** Venus has so much CO<sub>2</sub> in its atmosphere that its average temperature is 460°C.

Mars has so little CO<sub>2</sub> in its atmosphere that it is 37°C when the sun shines, but minus 123°C at night.

**QU. 6 (10 points). What are fossil fuels made from?**

- (a) Ancient rocks, turned into coal or oil by heat from the Earth's core
- (b) Dead dinosaurs, compressed together over millions of years
- (c) Ancient carbon-based plant matter and ocean life
- (d) Ancient protoplasm, melted by nuclear fusion from the Earth's molten core

**Answer:** (c) Ancient carbon-based plant matter and ocean life.

The ancient rocks and ancient protoplasm answers are total nonsense.

There may be the occasional fragment of dinosaur remains locked up in some coal, but not enough to be any use.

**QU. 7 (5 points). Which of the following is not a fossil fuel?**

- (a) Natural gas
- (b) Oil
- (c) Coal
- (d) Marmalade

**Answer:** (d) Marmalade

Bonus 10 points to anyone not on a team who can anyone explain why marmalade is not a fossil fuel. Five points for an adequate, but not great answer.



**QU. 8 (15 points).** Which of these four greenhouse gases do fossil fuels release, when they are burned?

- (a) Water vapour
- (b) Carbon dioxide
- (c) Methane
- (d) Ozone

**Answer:** (b) Carbon dioxide

Fossil fuels also release some water vapour, but its addition to the vast quantity of water vapour that's already in the atmosphere is insignificant.

Fossil fuels often release methane before they are burnt; but as soon as the methane burns, it is converted to CO<sub>2</sub>.

Ozone is produced by a mixture of pollutants that come from burning fossil fuels, but it is not released directly.

**QU. 9 (10 points).** Which of these activities does not contribute to global climate change?

- (a) Driving a car that burns gasoline
- (b) Driving a car that burns natural gas
- (c) Driving an electric car that uses electricity from a coal-fired power plant
- (d) Driving a car that burns biodiesel made from waste fats from restaurants

**Answer:** (d) Driving a car that burns biodiesel made from waste fats from restaurants

Gasoline, natural gas and the coal that is burnt to make the power for an electric vehicle are all fossil fuels, so the CO that they release contributes to global climate change. Biodiesel that is made from waste fats from restaurants originates in the plant material that was used to make the restaurant fats, and the plants absorbed CO<sub>2</sub> before they were processed to make the fats, so they are part of the natural carbon cycle, and do not contribute to global climate change.



**QU. 10 (10 points). Methane is also a greenhouse gas. Which of the following four sources does *not* generate methane?**

- (a) Swamps, and rotting underwater vegetation
- (b) Emissions from natural gas vehicles
- (c) Cows burping, from their two stomachs
- (d) Landfills, that hold rotting garbage

**Answer:** (b). The methane that is in natural gas breaks down into CO<sub>2</sub> when it is burnt in a car.

When the carbon in plant material breaks down in the presence of oxygen, it forms CO<sub>2</sub>.

When it breaks down in the absence of oxygen, it forms methane (CH<sub>4</sub>).

Methane comes from swamps, and rotting underwater vegetation; from landfills (where there is no oxygen as the material breaks down), and from the stomachs of cows, where there is also no oxygen. It is released when cows burp.

### In the event of a close finish:

**QU. 11: how many greenhouse gases can you name?**

Each team takes it in turn to name a gas, starting with the team with the lower score.

2 Bonus points per correct answer.

#### Answers

- Carbon dioxide – methane – nitrous oxide – Family of CFCs & HCFCs & HFCs – perfluorocarbons – sulfur hexafluoride – tropospheric ozone – water vapour
- Nitrous oxide comes from poor soil management, where the nitrogen in fertilizers is released into the air; from transportation pollution; and from some industrial processes.
- Perfluorocarbons (PFCs) come from the manufacture of aluminum, solvents and plasma.
- Sulfur hexafluoride (SF<sub>6</sub>) comes from the production of magnesium.
- Tropospheric ozone is produced by air pollution by transport and industry
- Water vapour is caused by evaporation of the world's oceans. It is the primary natural greenhouse gas, but it is not being increased by human activity in sufficient quantity to make any difference.

**The Winning Team receives a big round of applause, and the teams join the rest of the class.**



# Teacher Handout

## The Climate Challenge Game

### Round 2: Climate Change Impacts

**QU. 1 (10 points).** This question concerns the impact of global warming on the Arctic Ocean ice. If global warming continues, the summer ice could be all gone by 2050, and the year-round ice by 2100. This will affect the polar bears in various ways. Which of these four effects will be the most serious and life threatening to the bears, as the ice melts?

- (a) There will be a shorter season when they can hunt for walrus, so the bears will slowly starve to death.
- (b) The increased rain and warmer temperatures will cause the snow dens where the female raise their cubs to collapse, while the cubs are still very small and vulnerable.
- (c) There will be a shorter season when they can hunt for ringed seals, so the bears will slowly starve to death.
- (d) There will be fewer tourists standing around on the ice, making for easy prey, so the bears will slowly starve to death.

**Answer:** (c). The ringed seal is the bear's main diet, and for every week that the ice melts earlier, causing them to leave the ice and stop hunting, the bears lose 10 kg of weight.

Re (a): Polar bears do also eat walrus, but it is not their main diet.

Re (b): This is a serious danger to the bears, but the female bears will build another den, if one den collapses.

Re (d): The tourists never had much flesh on them, and the artificial fibre that they use for their winter gear tastes horrible, anyway, so they were never a large part of the bears' diet.





**QU. 2 (10 points).** As the temperature warms, the permafrost that covers most of the Arctic and northern lands is melting. Which of these four impacts is being caused by the melting permafrost?

- (a) The ice-roads which people use to cross lakes and rivers in the winter are melting earlier, and have to be closed, since they are no longer safe.
- (b) The large quantities of methane gas from ancient rotting vegetation that is stored in the permafrost is escaping, and may explode in a dangerous manner.
- (c) The land underneath houses, roads and bridges is collapsing, causing them to buckle and become dangerous.
- (d) It is becoming more dangerous to travel over land by snowmobile, since there are frequent patches of water and bare earth where there used to be snow.

**Answer:** (c). This is a big problem in Alaska and northern Canada. 50% of Canada's land is underlain by permafrost, and to remain frozen, it needs a year-round temperature below 0°C. Most houses and roads in the North do not have deep foundations, so as the permafrost melts, they can sag, buckle and collapse.

Re (a). The melting ice-roads are a result of the melting ice, not the melting permafrost.

Re (b). Methane gas *is* escaping from the permafrost, and this is a concern, since methane is also a greenhouse gas, but it does not explode, since it is not concentrated in one place.

Re (d). This is another result of climate change - caused by melting snow, not melting permafrost.

**QU. 3 (10 points).** This is a question about the global sea level. Scientists on the United Nations Intergovernmental Panel on Climate Change have studied the sea level, and they say it will rise by up to a metre by 2100, because of climate change. Which of these four reasons do they say is the reason for this rise in sea level?

- (a) The expansion of the water molecules in the sea, which is caused by the higher temperature of the water.
- (b) The increase in fresh water that is running into the oceans, as a result of increased rainfall around the world.
- (c) The melting of the Greenland and Antarctic ice caps.
- (d) The melting of the Arctic ice cap.

**Answer:** (a). As water warms, its molecules expand. Thirty of the world's major cities are close to sea level, including London, New York and Shanghai in China, and are threatened with serious flooding.

Re: (b). Rainwater accumulates in the sky by evaporation from the oceans. As the ocean surface warms, there is more evaporation, resulting in more rainfall, but this does not cause sea levels to rise.



Re: (c). This is a big concern in the long-term, since Greenland's ice cap sits above sea-level – some of it more than 3000 metres above sea level. The Antarctic ice cap is also above sea-level, and up to 2700 metres thick. There is some evidence that the ice in Greenland and the west Antarctic ice sheet is melting faster than normal, but it is not yet clear enough to have been included in the scientists' predictions.

Re: (d) The Arctic ice cap is already floating in the sea, so when it melts, it does not cause the sea level to rise.

**QU. 4. This question is about the different animals and plants in Canada's North, that will be affected by climate change. Each team will take it in turn to call out the name of a creature or plant that will be affected by climate change live in Canada's North, and *explain why it will be affected*. There are no penalty points for suggesting a wrong answer.**

For each correct answer, a team wins 2 points. For each correct explanation, that team wins an additional 3 points, creating a possible 5 points for each creature or plant affected. If Team A can not provide a good explanation, the opportunity is offered to Team B.

**Possible Answers:**

- Arctic char need really cold water, and will move to areas of the Arctic that are colder.
- Arctic ground squirrels: When the snow is deeper, the squirrels raise more babies.
- Brown bears have been spotted on the Arctic shoreline for the first time in memory.
- Caribou: There will be fewer numbers, due to deep snow and frozen crust, earlier break-up of rivers and lakes, and difficulty in getting to calving grounds
- Fish: As the permafrost melts, dirt and sediment falls into the rivers and is washed into the sea, making it difficult for fish to breathe and spawn.
- Moose: The warmer, wetter weather is causing willows to grow faster, providing more food.
- Mosquitoes are encouraged by the warmer weather
- Parasites and bugs: The warmer weather causes more parasites, which bothers the moose, caribou, sheep, & lynx
- Plants, shrubs and trees are moving northwards as the temperatures warm and moisture levels change, replacing the tundra environment. As the permafrost melts, trees are toppling, and new wetlands are being created, while other wetlands drain and dry up.
- Polar bears: Less ice means less time when they can hunt for food. See Qu. 1 above, too
- Ringed seals: Less ice means less opportunity to raise their young in safety
- Salmon: Pacific salmon are seeking out new rivers in the Arctic where they can breed, as the ocean warms.
- Songbirds. There is an observed decline in their numbers. This may be related to climate change; it may also be caused by a loss of the summer habitat, in Canada, the USA and Mexico.



- Turkey vultures are moving north. One was caught at Fort McPherson in 2002, where they have never been seen before.
- Walrus: Less ice means fewer places where they can raise their young in safety.
- Whitetail deer coyotes and cougars: All being seen further north than normal.

**QU. 5 (10 points).** This is a question about the increasing global temperatures that scientists are predicting. The average global temperature increased by  $0.6^{\circ}\text{C}$  between 1900 and 2000. Some regions in the Arctic warmed by as much as  $5^{\circ}\text{C}$  in the same period. According to the scientists' computer models, how much warmer might the Earth become by 2010?

- (a)  $2.8^{\circ}\text{C}$
- (b)  $3.8^{\circ}\text{C}$
- (c)  $4.8^{\circ}\text{C}$
- (d)  $5.8^{\circ}\text{C}$

**Answer:** (d). The computer models used in the 2001 United Nations report on climate change showed a number of possible future temperatures, ranging from  $1.4^{\circ}\text{C}$  to  $5.8^{\circ}\text{C}$ . A study by British scientists at the Hadley Centre for Climate Prediction and Research in England, which was published after the UN report, has predicted a global rise of  $8^{\circ}\text{C}$  by 2100.

**QU. 6 (10 points).** This is a question about the impact of global climate change on Canada's forests. Which one of these four statements is most correct?

- (a) The biggest danger to the forests comes from increased forest fires, because of the hot, dry summers.
- (b) The biggest danger to the forests comes from increased rainfall and snow, which causes mudslides and avalanches.
- (c) The biggest danger to the forests comes from increased damage by pests, which like the warmer weather.
- (d) The biggest danger to the forests comes from increased tourism, logging, and oil and gas activity, which is made easier by the warmer weather.

**Answer:** (c). Pests. In British Columbia, by 2003, the mountain pine beetle had destroyed more than 600,000 hectares of forest, more than the whole of Sweden.

Re (a). Fire. In the record-breaking forest fire season of 2003, BC lost 263,000 hectares to fire. The normal annual loss is 33,000 hectares.

Re (b). Mudslides and avalanches are dangerous to humans, but not to forests.

Re (d). The warmer weather is making it harder for logging and industrial operations to happen in the north, not easier, because of the melting permafrost.



**QU. 7 (10 points).** This question is about the increasing number of storms, floods and weather-related disasters around the world that are being caused by climate change. Which of the following kinds of disaster is *not* linked to global climate change?

- (a) Sudden downpours, floods and mudslides
- (b) An increase in the number of earthquakes
- (c) Extreme heatwaves
- (d) Extreme droughts

**Answer:** (b). There is no known connection between climate change and earthquakes. All of the others are showing a clear increase. The global re-insurance industry, which provides insurance for the insurance companies, is alarmed at the growing cost of insurance claims that are related to climate change.

**QU. 8.** This is a question about the impacts that global climate change is having – or will have – on businesses in Canada. Each team will take it in turn to call out the name of a type of business that will be affected by climate change in Canada, and explain why it will be affected. There are no penalty points for suggesting a wrong answer.

For each correct answer, a team wins 2 points. For each correct explanation, that team wins an additional 3 points, creating a possible 5 points for each business affected. If Team A cannot provide a good explanation, the opportunity is offered to Team B.

**Possible Answers:**

- Farming: Possible increased production in the North, as a result of the warmer weather. Possible decreased production, from more droughts and heat waves.
- Fishing: Some fish species will benefit from the warmer water, others will not.
- Forestry: Losses from pest damage, forest fires, and a higher growing temperature (= less growth).
- Hunting: Ringed seals, walrus and caribou will all become scarcer.
- Insurance: Increased claims from disasters.
- Oil and gas: Production could increase, as year round ocean drilling becomes possible. It could also decrease, as drilling on the tundra becomes more difficult, with the melting permafrost.
- Shipping: New Arctic routes will open up.
- Skiing: Loss of snow cover
- Solar and wind energy: Production will increase, as an alternative to diesel, oil, coal and gas.
- Tourism: Arctic tourism could increase, with the warmer weather in summer



**QU. 9 (10 points).** This is a question about the **HUMAN HEALTH IMPACTS** of global climate change. Which of these four diseases, all of which are increasing in the world, is causing the greatest suffering due to global climate change?

- (a) SARS (Sudden Acute Respiratory Virus)
- (b) West Nile Disease
- (c) Malaria
- (d) Mad Cow Disease

**Answer:** (c). Malaria is spread by malaria-carrying mosquitoes, which are moving north as the climate warms. Malaria kills millions of people every year, mostly in the developing nations.

Re (a) SARS is not caused by global climate change. It is probably caused by a virus that crosses to humans from wild animals that are captured for food in China.

Re (b) West Nile Virus is carried by mosquitoes which are moving north as the climate warms, but the disease kills very few people, compared to malaria.

Re (d) Mad Cow Disease is not caused by global climate change. It is probably caused by cows being fed contaminated meat from diseased cows or sheep that were infected with a disease called scrapie.

**QU. 10 (10 points).** We are getting towards the end of the quiz. This question is about a concern that some scientists have about “**abrupt climate change**”, which could happen as the effects of climate change impact on each other, making things much worse. Which of the following possibilities is *not* caused by global climate change?

- (a) As the world’s temperatures increase, the tropical forests will begin to die, releasing the carbon that is stored in them, making things much worse.
- (b) As more of the world’s oil supply is used up, it will cause military and political conflict, as nations compete to control the remaining supplies of oil.
- (c) As the Arctic ice melts, it will release millions of tonnes of fresh water into the North Atlantic Ocean, diluting the salt water. This will cause the warm Atlantic current known as the Gulf Stream to slow down and then switch off, plunging northern Europe into a possible ice age.
- (d) As the tundra thaws, it will release the vast quantities of carbon and methane that have been stored there for hundreds of thousands of years, adding yet more to the world’s burden of greenhouse gases.

**Answer:** (b). Burning oil releases CO<sub>2</sub>, and causes climate change, but conflicts over the world’s oil fields are not related to global climate change.



Re (a). Scientists at the Hadley Centre for Climate Research in England are concerned that the Amazon forest will start to dry out around 2040, releasing billions of tonnes of carbon, instead of storing it.

Re (c). This is a growing concern as the Arctic ice thins, and the Greenland icecap begins to melt. There is already evidence that the Gulf Stream is beginning to slow. The Gulf Stream is part of the world's thermohaline current (thermohaline means 'warm and salty'), which is driven by the high salt content of water off Iceland. The salty water is heavier than fresh water, so it sinks to the bottom of the ocean, setting the thermohaline current in motion. The water off Iceland is saltier, because the Arctic sea ice locks up so much fresh water. As the ice melts, it is diluting the salty water, leading to the concern that the whole global current could stop – as it has been known to do in the past. For an illustration of the current, see [www.grida.no/climate/vital/32.htm](http://www.grida.no/climate/vital/32.htm)

Re (d). This is already happening, but the area of tundra over which the thawing is happening is so large that nobody has been able to gather reliable statistics.

**QU. 11 (10 points).** Given what you have just learnt, what do you think is the best response to all this?

- (a) We should get out into the streets, and on television, and start protesting, to make people wake up and do something.
- (b) There should be much more research, so that we have a better understanding of what is happening.
- (c) We should become more politically involved, so that our governments become more active in seeking a lasting solution.
- (d) We should keep on partying, because no-one's going to do anything about all this, and nobody's going to listen to us.

After both teams have decided, there is a full class discussion, at the end of which, everyone votes on the 4 options. The team that chose the response that wins the most votes wins the points. If both teams have the same answer, they get 5 points each. Everyone in the class who voted for the most popular answer wins 5 points.

**The Winning Team receives a big round of applause, and the teams join the rest of the class.**



# Teacher Handout

## The Climate Challenge Game

### Round 3: Global Solutions to Climate Change

**QU. 1 (10 points).** Which of the following nations produces the most CO<sub>2</sub> per person?

- (a) Canada
- (b) Russia
- (c) USA
- (d) China

**Answer:** (c) USA – 20 tonnes per person. Canada is next with 19 tonnes per person

**QU. 2.** This is a question about **SOLAR ENERGY**. It comes in two parts, each worth 5 points. Solar energy is generated by the use of photovoltaic cells, which capture the sun's light and turn it into electricity. By putting a solar panel on your roof, you can generate clean, renewable electricity.

**QU. 2A (5 points).** Which of the following breakthroughs will allow the world to benefit from the use of solar energy on a widespread scale?

- (a) Improvements in the efficiency of photovoltaic cells, so that they generate more energy.
- (b) Government policies that require the use of solar energy on all government and other buildings.
- (c) Mass production – so that the cost of solar energy falls, and people can afford it.
- (d) The use of photovoltaic cells made from water, etched with a crystalline surface

**Answer:** (c) As soon as one factory has enough demand to manufacture 500 MW of solar PV cells a year, the price will start to fall dramatically. The Japanese company Sharp plans to open a 500 MW factory in 2005.

Improvements in the efficiency of photovoltaic cells (a) are important, but they are very small, and gradual. This could change, of course, if there was a major breakthrough.

Government policies (b) are also important, but they will not cause the breakthrough on their own.

Photovoltaic cells made from water (d) is a nonsense idea.



**QU. 2B. (5 points). How large an area of land would you need to cover with photovoltaic cells if you wanted to generate enough electricity to supply Canada with all the electricity it needs?**

- (a) The whole of Alberta, Saskatchewan and Manitoba
- (b) One eightieth of Manitoba
- (c) Half of Alberta
- (d) All of Saskatchewan

**Answer:** (b) One eightieth of Manitoba

This correct answer is quite astonishing. Well-researched data has shown that the electricity needs of the entire US electric grid could be met from an area that is 100 miles by 100 miles (10,000 sq. miles), if it were covered in solar PV cells. Canada's population is 1/10<sup>th</sup> America's, so the equivalent is 1,000 square miles. Solar exposure in Manitoba is weaker, so the number has been trebled to 3,000 square miles. Manitoba is 251,000 square miles, so 3000 square miles is 1.25% (1/80<sup>th</sup>) of the land area. No one is suggesting we do this – it is just a theoretical calculation. It is much more sensible to place the solar panels on roofs, above parking lots, etc.

**QU. 3 This is a question is about WIND ENERGY. It comes in 3 parts, each worth 5 points.**

**QU. 3A. (5 points). How much does wind energy cost to produce?**

- (a) 5 cents a kilowatt-hour – the same as hydroelectric or coal-fired power
- (b) 7 cents a kilowatt-hour – more than hydroelectric power
- (c) 9 cents a kilowatt-hour – the same as gas-generated power
- (d) 21 cents a kilowatt-hour – the same as nuclear power

**Answer:** (b) 7 cents a kilowatt-hour – more than hydroelectric power

**QU. 3B. (5 points). In Europe, how much electricity could be generated from wind turbines placed in the southern North Sea, where it is relatively easy to build them?**

- (a) Half of all the electricity that Germany needs
- (b) Twice as much electricity as Germany needs
- (c) Three times more electricity than Germany and Denmark need together
- (d) Three times more electricity than Germany, Denmark, Holland, Belgium and Britain need together

**Answer:** (d) This is astonishing, but true. The 2001 report which produced this data, "North Sea Offshore Wind: A European Powerhouse," was prepared by the German Wind Energy Institute.





**QU. 3C. (5 points).** How fast is the global production of wind energy increasing each year?

- (a) 5%
- (b) 17%
- (c) 26%
- (d) 35%

**Answer:** (d) 35%. By the end of 2002, the global production of electricity from wind turbines was 31,000 MW. For a photo of the two wind turbines in Whitehorse, see [www.yec.yk.ca/main.php?inline=frame\\_wind.htm&hilo=rich](http://www.yec.yk.ca/main.php?inline=frame_wind.htm&hilo=rich)

**QU. 4 (5 points).** This is a question is about energy efficiency – making our homes, cars, appliances, & factories more efficient, so that they use less power. If everything we used were twice as efficient, how much electricity would we need to generate?

- (a) The same amount as we do today
- (b) Twice as much as we do today
- (c) Four times as much as we do today
- (d) Half as much as we do today

**Answer:** (b) Twice as much as we do today. This is a trick question, to make sure they're thinking.

**QU. 5 this is a question is about TRANSPORT. It comes in 2 parts, each worth 5 points.**

**QU. 5A (5 points).** This is about the oil that we use to fuel our cars, trucks, buses, and airplanes. The amount of oil that is available to us was laid down millions of years ago, so as we use it up, there is less left in the ground. The term “the oil peak” is used to describe the time when the total quantity of oil produced in a year starts to fall. How soon will this occur?

- (a) It has already happened
- (b) Sometime between 2005 and 2020
- (c) Sometime between 2020 and 2050
- (d) Sometime after 2050

**Answer:** (b) Sometime between 2005 and 2020

Some private energy analysts say that it will occur in 2005; the US Energy Information Administration says it will occur in 2020. The correct date may be anywhere in-between.



**QU. 5B (5 points).** Which of these is the quickest and easiest way for the world to use less oil, and reduce the greenhouse emissions that come from burning oil?

- (a) Build cars and trucks that are twice as efficient
- (b) Build cars and trucks that run on hydrogen
- (c) Build cars and trucks that run on electricity
- (d) Build cars and trucks that run on natural gas

**Answer:** (a) Build cars and trucks that are twice as efficient. This could be done today.

Re (b): The infrastructure is not ready for the mass production or distribution of hydrogen. If the hydrogen is made from fossil fuels, it will still release CO<sub>2</sub>.

Re: (c) No-one has solved the problem that batteries only offer power for a limited distance.

Re: (d) Natural gas is still a fossil fuel, which releases greenhouse gas emissions.

**QU. 6 (10 points).** This is a question about FARMING. In North America, farming is responsible for 8% of the greenhouse gases that cause global warming. Which of these changed farming practices would lead to the greatest reduction in greenhouse gases?

- (a) Changing to organic farming, or using less nitrogen fertilizer, since the mis-use and overuse of nitrogen fertilizer causes the release of nitrous oxide, which is a powerful greenhouse gas.
- (b) Farming more fruits and vegetables, instead of beef and dairy, since cows release large amounts of methane gas from their stomachs, through constant belching.
- (c) Collecting all the liquid manure that is produced in the big hog farms, so that the methane gas, which the hog manure produces, can be captured, and used to generate energy.
- (d) Changing the ways the farmers manage their land, so that the topsoil (which stores huge quantities of carbon) is not blown away when they plough it.

**Answer:** (a) Changing to organic farming. The release of nitrous oxides from farming releases 8.2 million tonnes of CO<sub>2</sub> per year.

Re: (b) Methane from cattle farming releases 4.9 million tonnes of CO<sub>2</sub> per year in Canada.

Re: (c) Methane from liquid manure releases 1.4 million tonnes of CO<sub>2</sub> per year in Canada.

Re: (d) The loss of topsoil through poor farming methods releases 0.3 million tonnes of CO<sub>2</sub> per year in Canada.



**QU. 7** this is a question about **GLOBAL GREENHOUSE GASES**. It comes in 3 parts, each worth 5 points.

**QU. 7A (5 points).** What is the name of the global treaty that many nations have signed, in which they agree to reduce their greenhouse gas emissions by 5% below the 1990 level by 2012?

- (a) The Montreal Protocol
- (b) The Geneva Convention
- (c) The Kyoto Protocol
- (d) The Houston Agreement

**Answer:** (c) The Kyoto Protocol, signed in Kyoto, Japan, in 1997. It still needs Russia to ratify it, before it takes full effect.

The Montreal Protocol is the treaty that is protecting the ozone layer.

The Geneva Convention is the treaty that addresses war crimes, and the treatment of prisoners of war.

The Houston Agreement – there is no such agreement.

**QU. 7B (5 points).** During the negotiations for the Kyoto treaty, which two countries tried constantly to sabotage and undermine it?

- (a) Iran and Iraq
- (b) The USA and Canada
- (c) Saudi Arabia and Kuwait
- (d) Japan and Indonesia

**Answer:** (c) Saudi Arabia and Kuwait. Delegates from these countries were helped by a US lobbyist for the oil industry, and tried to delay, obstruct and sabotage the treaty at every stage.

**QU. 7C (5 points).** How large a reduction in greenhouse gas emissions do the world's climate scientists say is needed, in order to prevent global warming from running out of control?

- (a) 15%
- (b) 30%
- (c) 45%
- (d) 60%

**Answer:** (d) 60%. When all factors are taken into account, the Kyoto Treaty will produce a 2% reduction in emissions below the 1990 level (10% below today's level). The challenge of moving to an energy system that is not based on fossil fuels is enormous, and exciting.



**QU. 8 (10 points).** This is a question about **NUCLEAR POWER**. Some people say we should build more nuclear power plants, since nuclear power does not generate much greenhouse gas emissions. Others disagree, because nuclear power plants produce wastes that remain radioactive for a long time, and there is no safe way to dispose of them. How long do some nuclear wastes remain radioactive for?

- (a) 100 years
- (b) 1,000 years
- (c) 50,000 years
- (d) Over 100,000 years

**Answer:** (d) Over 100,000 years. See [www.emnrd.state.nm.us/wipp/radprimer.htm](http://www.emnrd.state.nm.us/wipp/radprimer.htm).

What was happening on the Earth 100,000 years ago?

What were humans doing? (We were still living in Africa).

**QU. 9 (10 points).** There are several other ideas that are being explored, as a way to reduce our greenhouse gas emissions, and slow global warming. Which one of the following ideas is being considered seriously, with big investments?

- (a) Producing energy from large solar power stations in space, which beam energy down to Earth.
- (b) Producing energy from anti-matter engines, which generate energy when matter and anti-matter collide.
- (c) Producing energy by burning “clean” coal, which produces no CO<sub>2</sub> emissions.
- (d) Producing energy through cold fusion – the process by which atomic nuclei fuse together to produce a single nucleus (in contrast to nuclear fission, where the nucleus breaks apart).

**Answer:** (c) Billions of dollars are being spent by the US and Canadian governments to help the coal industry create “clean” coal. The escaping CO<sub>2</sub> emissions are captured at the power plants where the coal is burnt, and then stored away underground. It is possible, but it will probably be very expensive.

Re (a) Solar stations in space is a wild idea that is being promoted by a few individuals.

Re (b) NASA is working on anti-matter engines, but no one is expecting a breakthrough, except in StarTrek, where anti-matter powers the Starship *Enterprise*.

Re (d) Cold fusion has been tried, but nobody has been able to make it work.



**QU. 10 (10 points). This question is different. Instead of being scored by whether your answer is correct or not, each team will be scored by the response you get from the rest of the class. Each team should consider the question for three minutes, and then choose someone to answer it.**

After both people have given their answer, the Quizmaster will ask the class which answer they like the best. The class can respond by clapping and cheering (in which case the team which earns the most noise wins), or by a show of hands (in case the noise will disturb other classes).

While the teams are thinking, everyone else in the class should form into groups of three, and think what their answers are, too.

**Living in Canada's North, some people argue that there is little we can do to influence what's happening in the world, since there are so few people, and all the big decisions are made in Ottawa, Washington, or Beijing.**

**What do you think people living in the North should do, if we want to try to stop global warming, and prevent the Arctic from melting?**

There is no correct answer to this. It is a matter of opinion. As author of this Lesson Plan, my personal opinion is that northern communities need to kick up stink, and take their concerns on the road, so that the rest of the world wakes up. The Arctic is melting – very fast.

**The Winning Team receives a big round of applause, and the teams join the rest of the class.**



# Teacher Handout

## The Climate Challenge Game

### Round 4: Local Solutions to Climate Change

**QU. 1 (10 points).** How many tonnes of greenhouse gases will a typical community of 5,000 people living in the north produce in a year?

- (a) 25,000 tonnes
- (b) 50,000 tonnes
- (c) 80,000 tonnes
- (d) 100,000 tonnes

**Answer:** (d) 100,000 tonnes. The Canadian average is 19 tonnes of CO<sub>2</sub> per person, the second highest in the world, after America (20 tonnes).

**QU. 2 (10 points.)** How much energy could a community save, if all of its houses and buildings were made really energy efficient, using good insulation, and the very best windows?

- (a) 5%–15%
- (b) 16%–25%
- (c) 26%–50%
- (d) More than 50%

**Answer:** (d) More than 50%. If you have really thick insulation in the roof, walls and basement, seal up all the gaps, install triple-glazed windows, and switch over to the most efficient fridges, washers, dryers, and lightbulbs, a 50% or more saving in energy is possible.



**QU. 3 (10 points).** People often talk about wind turbines being a possible solution, and a way to generate clean, renewable power. What is the biggest problem with wind turbines in the north?

- (a) There's not enough wind for them to make any commercial sense.
- (b) Chunks of ice fly off the blades when it gets really cold, which can be dangerous.
- (c) They will kill the migrating birds, in the summer.
- (d) Many people think it's easier to go on burning diesel, because it is totally reliable.

**Answer:** (d) Resistance by local utility managers is the main reason why there are not more wind turbines in Canada's north. Three 50-kilowatt turbines were built in the Arctic tundra near Kotzebue, Alaska, in 1997, and at least 80 remote villages in northern and western Alaska are thought to have sufficient wind to make wind turbines viable for production. Some wind turbines in Alaska produce more than their maximum rated power output because air becomes denser at lower temperatures. This effect can cause a 20% increase in maximum power output at  $-37^{\circ}\text{C}$ .

Re (a): Wind costs 7 cents kW.h (more for remote communities), and once the turbines have been installed, there are no shipping costs, as there are for diesel. The price of wind energy remains fixed, unlike the price of diesel, which will rise as soon as global oil shortages begin.

Re (b): Chunks of ice flying off is a problem, but not the biggest problem. The team that is behind the two turbines in Whitehorse are doing research to find a non-stick surface for the blades.

Re (c): The large new turbines turn very slowly, and have little or no effect on birds. It is the older, smaller wind turbines, which spin very fast and kill birds.

**QU. 4 (10 points)** This question is about **TRANSPORT**, and the way we get around. It has 3 parts. Each part wins 5 points:

**QU. 4A (5 points).** Which of the following means of transport produces the fewest greenhouse gas emissions, per person?

- (a) Cycling
- (b) Riding a bus that is full
- (c) Riding a bus that is almost empty
- (d) Driving a hybrid, gas-electric car

**Answer:** (a) Cycling. Buses and hybrid cars still burn gasoline or diesel.



**QU. 4B (5 points). Which of these cars produces the fewest greenhouse gas emissions?**

- (a) A Honda Civic with a gas-electric hybrid drive
- (b) An electric car, which is charged using electricity produced by burning diesel or natural gas
- (c) A Volkswagen Beetle diesel car
- (d) An electric car, that is charged using electricity produced by solar or wind power

**Answer:** (d) An electric car powered by solar or wind produces no greenhouse gas emissions at all, except during manufacture. The Honda Civic hybrid comes next, then the Beetle, and then the electric car in (b)

**QU. 4C (5 points). Which kind of snowmobile engine produces the fewest greenhouse gas emissions?**

- (a) A diesel or biodiesel engine.
- (b) A 4-stroke gasoline engine.
- (c) A 2-stroke gasoline engine with fuel injection and a catalytic converter.
- (d) An electric engine, charged using electricity from solar or wind energy.

**Answer:** (d) Electric snowmobiles do exist, so they could in theory be charged up with power from solar or wind energy.

A 4-stroke gasoline engine is more efficient than a 2-stroke gasoline engine with fuel injection and a catalytic converter. There are no diesel snowmobiles. If there were, they could be fuelled with biodiesel, which would also produce no greenhouse gas emissions.

See [www.admin.mtu.edu/urel/snowmobile](http://www.admin.mtu.edu/urel/snowmobile)

[www.evworld.com/databases/shownews.cfm?pageid=news150702-07](http://www.evworld.com/databases/shownews.cfm?pageid=news150702-07)

[www.xanterra-corporate.com/environment/static/ENV1062.htm](http://www.xanterra-corporate.com/environment/static/ENV1062.htm)

[www.deq.state.mt.us/CleanSnowmobile/solutions/engine/electric.htm](http://www.deq.state.mt.us/CleanSnowmobile/solutions/engine/electric.htm)

Clean Snowmobile Challenge;

[www.deq.state.mt.us/CleanSnowmobile/solutions/challenge/index.html](http://www.deq.state.mt.us/CleanSnowmobile/solutions/challenge/index.html)





**QU. 5 (10 points). This is a question about diesel, which is used in many communities to generate power. Which of these four statements is correct?**

- (a) Diesel is not a fossil fuel, because when Rudolf Diesel invented the diesel engine in 1895, he designed it to run on peanut oil and other vegetable oils, including hemp.
- (b) If a truck, bus or power generator runs on diesel, it can also run on biodiesel made from vegetable oils, or waste fat from a restaurant.
- (c) Diesel may be a polluting fuel that produces carbon dioxide, but at least it will never run out.
- (d) Most communities in the North would grind to an immediate halt without diesel, because there are no alternative fuels that can run trucks, buses and machinery, and generate electricity.

**Answer:** (b)

Re (a): The diesel that we use today is made from oil, not peanuts or hemp.

Re (c): The world's oil supply (which diesel comes from) will start diminishing between 2005 and 2020.

Re (d): There are various ways to make energy that do not require the use of fossil fuels, such as from the wind, solar, geothermal heat, biomass, biodiesel, and with hydrogen fuel cells.

**QU. 6 (10 points). This is a question about tidal energy – the idea that you can generate energy from the power in the ocean's tides, as the water flows back and forth. Which of these four statements is correct?**

- (a) Tidal energy is a good idea, but nobody has been able to make it work yet.
- (b) Tidal energy could never work in the Arctic, because of all the ice.
- (c) Tidal energy is already being generated in the Arctic.
- (d) Tidal energy in the Arctic would be a hazard to the polar bears and seals, because of the underwater turbines.

**Answer:** (c) The world's first tidal turbine was installed at Hammerskaer, off Norway's Arctic Coast, in 2002.

Re (a): Tidal turbines are also operating in France, and off the Devon coast of England and in the Bay of Fundy in Canada.

Re (b): Tidal turbines run under the ice, not at the surface.

Re (d): The turbines spin very slowly, at 25 rpm, so there would not be a danger to wildlife.



**QU. 7 (10 points).** This is a question about geothermal heat. This is a system that captures the earth's underground warmth in pipes, and transfers it into a building using a heat pump. Which of these four statements is correct?

- (a) Geothermal heat is one of those ideas that inventors think up, but never really works
- (b) Geothermal heat is not possible in the North, because the ground is too cold
- (c) Geothermal heat is more cost effective if the ground is made from soil and sand, not rock.
- (d) Geothermal heat requires as much energy for the pumping as it extracts in heat.

**Answer:** (c) It costs more to drill into rock than it does to lay lines in soil or sand.

Re (a): There are many ground-source heat systems operating in Manitoba, and around the world,

Re (b): Two metres below the ground, the temperature is stable, and warmer than the surface temperature.

Re (d): For every one unit of energy put in to run the pump, four units of energy are returned.

See [www.earthenergy.ca](http://www.earthenergy.ca) for a diagram that shows how ground-source energy works.

**QU. 8 (10 points).** This is a question about small-scale hydro, which is a way to generate energy from the flow of water in a river. Which of these four statements is correct?

- (a) Small-scale hydro is not used in the North, because rivers and creeks are frozen throughout the winter.
- (b) Small-scale hydro used to be done in the old days, but these days it is more efficient to build a big dam, because it will produce much more energy.
- (c) Small-scale hydro is undergoing a revival in popularity, because it is a good way to generate clean, renewable energy
- (d) Small-scale hydro projects are environmentally harmful, because they stop fish from migrating upstream.

**Answer:** (c)

Re (a): There is a small-scale hydro plant east of Whitehorse, high up in the mountain pass on the road to Skagway. It draws water from under the ice.

Re (b): It is the big dams that are losing popularity since they flood so much land. Small-scale hydro schemes cost around 5.5 cents/ kWh, and are a very cost-effective way to generate power.

Re (d): There are careful systems to ensure that when water is diverted from a creek or river to flow through a small-scale hydro turbine, the fish are not disturbed.



**QU. 9 (10 points).** This question is called ‘thinking outside the box.’ Which of these four statements are many scientists and engineers seriously considering?

- (a) In the future, people in northern communities will keep themselves warm in winter by covering themselves entirely in huge glass or plastic domes, to keep the cold out.
- (b) In the future, people in northern communities will generate the energy they need by putting giant solar collectors into space, and beaming their energy down to a collector next to the community.
- (c) In the future, people in northern communities will be able to generate the power and heat they need by burning the methane that is locked up in the frozen tundra, as global warming causes it to melt.
- (d) In the future, people in northern communities will live in homes and buildings that are so well designed and insulated that they won’t need any heating at all, even in the winter.

**Answer:** (d) There is research going on into super-efficient homes all over the world. It is possible that in a super-efficient home, the heat from our own bodies could keep us warm, even in winter.

Re (a): No-one is suggesting that northern communities should cover themselves with glass or plastic domes. Maybe they should?

Re (b): There is a small band of “solar beam” engineers who think it’s a great idea, but few people are taking the idea seriously. The cost would be enormous, and so would the difficulties of repairing damage from space debris, and the danger if the solar beam was knocked off course.

Re (c): The escaping methane is spread around over such a wide area that it is impossible to collect. There are engineers who want to mine the oceans for methane hydrates – giant chunks of frozen methane gas, that sit on the ocean floor – but many people find the idea alarming, since methane is a very powerful greenhouse gas.



**QU. 10 (10 points) This point is different. Instead of being scored by whether your answer is correct or not, each team will be scored by the response it gets from the rest of the class. Discuss the question the question for two minutes, and then choose someone to answer it.**

After both teams have given their answer, the Quizmaster will ask the class which answer they liked the best. The class can respond by clapping and cheering (in which case the team which earns the most noise wins), or by a show of hands.

**“The threat to the Arctic from global climate change is so serious that the only rational response by people who live in the north is to become political, and lobby people in other countries to stop producing greenhouse gases.” Do you agree or disagree with this statement, and if so, why?**

This is all good food for discussion.

**The Winning Team receives a big round of applause, and the teams join the rest of the class.**



# Teacher Handout

## The Climate Challenge Game

### Round 5: Personal Solutions To Climate Change

**QU. 1 (10 points).** How much greenhouse gas does the average Canadian produce in a year from driving, heating the home, using electricity, and flying, etc?

- (a) 1 tonne
- (b) 5 tonnes
- (c) 19 tonnes
- (d) 32 tonnes

**Answer:** (b) 5 tonnes of CO<sub>2</sub>.

**QU. 2** This question is about Driving. It comes in 4 parts, each of which is worth 5 points.

**QU. 2A (5 points).** How many kilograms of carbon dioxide does a car produce for each litre of gasoline it burns?

- (a) 0.025 kg
- (b) 0.25 kg
- (c) 2.5 kg
- (d) 25 kg

**Answer:** (c) 2.5 kg

**QU. 2B (5 points).** How is it possible that the carbon dioxide that is released by burning a litre of gasoline weighs more than the gasoline itself?

- (a) The CO<sub>2</sub> is heavier because the carbon from the gasoline gets mixed up with oxygen from the atmosphere.
- (b) The CO<sub>2</sub> is heavier because it mixes with gravity when it is released from the gasoline.
- (c) The CO<sub>2</sub> is heavier because the energy that was used to drive the car becomes mixed up with the car's exhaust fumes.
- (d) The CO<sub>2</sub> is heavier because all greenhouse gases are heavy – that's why they get trapped in the atmosphere.



**Answer:** (a). As soon as a molecule of carbon (C) is released from the fuel, it mixes with two molecules of oxygen (O). One kilo of carbon becomes 3.667 kilos of CO<sub>2</sub>.

(b). (c) and (d) are all mixed up thinking.

**QU. 2C (5 points).** Listen up very carefully. This is not a trick question. Now you know how many kilograms of carbon dioxide a car produces for each litre of gasoline (2.5 kg). If a car burns 8 litres of gasoline for every 100 km it travels, how many kilograms of carbon dioxide will it produce during a year, if the owner drives 15,000 km?

- (a) 800 kg
- (b) 1,200 kg
- (c) 3,000 kg
- (d) 1,500 kg

**Answer:** (c) 3000 kg. If you drive 15,000 km in a car that burns 8 litres per 100 km, you'll burn 1200 litres of gas. Each litre releases 2.5 kg of CO<sub>2</sub>, so the correct answer is 3,000 kg, or 3 tonnes.

**QU. 2D (5 points).** Here are four ways that will reduce the greenhouse gas emissions that a vehicle produces. I want you to place them in order, with the method that causes the greatest reduction in emissions listed first.

- (a) Turn the engine off instead of idling, if you are waiting for someone, or at the traffic lights.
- (b) Switch to a more fuel-efficient vehicle.
- (c) Stop driving – switch to walking, cycling or taking the bus instead.
- (d) Check your tire pressure, and make sure your car is well serviced.

**Answer.** The correct order is:

- (c) Stop driving.
- (b) Switch to a more fuel-efficient vehicle.
- (a) Turn the engine off instead of idling.
- (d) Check your tire pressure, and make sure your car is well serviced.



**QU. 3 (10 points).** This question is about walking and cycling. Which of the following excuses do you think is the most pathetic reason for not walking or cycling to the shops, to school, or to see a friend, when it's not snowing?

- (a) It will take me too long.
- (b) It's too cold.
- (c) Why bother, if someone in my family, or a neighbour, is willing to drive me?
- (d) My mum says it's dangerous – someone might attack me.

After the teams have made their choice, everyone the class will vote on which of the four excuses they think is the most pathetic. The team whose answer matches the class's answer wins the points. If both teams have the same answer, they get 5 points each. Everyone in the class who voted for the "winning" excuse wins 5 points.

This is all food for discussion

**QU. 4** This question is about Recycling. It comes in 4 parts, each of which is worth 5 points.

**QU. 4A (5 points).** When trees are left standing, they gather and store carbon from the atmosphere. If you use paper that is made from 100% post-consumer recycled paper instead of trees, how many trees will be left standing for each tonne of paper that you use?

- (a) 2
- (b) 8
- (c) 17
- (d) 29

**Answer:** (c) 17.

**QU. 4B (5 points).** When aluminum is made, a lot of energy is used, and producing the energy usually produces a lot of greenhouse gas emissions. When you recycle an aluminum can, how much energy can be saved by making new cans from the recycled aluminum?

- (a) 18%
- (b) 36%
- (c) 72%
- (d) 95%

**Answer:** (d) 95%



**QU. 4C (5 points).** When steel is made, a lot of energy is also used (but nowhere near as much as aluminum). When you recycle a steel can, how much energy can be saved by making new cans from recycled steel?

- (a) 15%
- (b) 34%
- (c) 61%
- (d) 88%

**Answer:** (c) 61%

**QU. 4D (5 points).** When plastic is made, a lot of energy is used. When you recycle your hard plastic containers, how much energy can be saved by making new plastic products from recycled plastic?

- (a) 8%
- (b) 33%
- (c) 79%
- (d) 94%

**Answer:** (b) 33%

**QU. 5 (10 points)** Airplanes burn kerosene, which is a fossil fuel, so they release CO<sub>2</sub> when they fly. If you fly from Whitehorse to Vancouver, or from Yellowknife to Calgary, how much CO<sub>2</sub> will you produce, as your personal share of the flight?

- (a) 50 kg
- (b) 357 kg
- (c) 850 kg
- (d) 1200 kg

**Answer:** (d) 1200 kg (1.2 tonnes). You can find out what your CO<sub>2</sub> emissions are for any flight by going to <http://www.chooseclimate.org/flying/> and marking your origin and your destination.





**QU. 6** This is a question about the appliances we use in our homes. It come in 3 parts, each of which is worth 5 points. All appliances use power, and if that power comes from diesel oil, natural gas or coal, it will release greenhouse gas emissions.

**QU. 6A (5 points).** Which of these appliances uses the most power, over the course of a year?

- (a) A water heater
- (b) A fridge
- (c) A microwave
- (d) A dryer

**Answer:** (a) A water heater

**QU. 6B (5 points).** Pay careful attention. This question needs some math. If electricity costs 6 cents for each kilowatt hour, and an old fridge uses 1200 kW.h of electricity a year, how much money will you save in a year if you replace it with a fridge that only uses 520 kW.h a year? (Teachers – you should adjust the cost, and the answer, based on the actual local cost).

- (a) \$10
- (b) \$20
- (c) \$40
- (d) \$80

**Answer:** (c) \$41. 1200 kW.h at 6 cents comes to \$72. 520 kW.h at 6 cents comes to \$31. The saving is \$41 a year, so \$40 wins.

**QU. 6C (5 points).** How many different types of appliance or device can you think of that use electricity in an average home? You have 2 minutes.

After 2 minutes, each team in turn calls out one appliance or device. The Quizmaster writes down the appliances that each team thinks of on the blackboard, and the team with the most wins. Any student whose total comes close also wins the 5 points.



**QU. 7. This question is about the way we heat our homes. It comes in two parts, each of which is worth 5 points.**

**QU. 7A (5 points). What is the cheapest way to keep warm in a house, while using less fuel or electric power?**

- (a) Add extra insulation to the roof
- (b) Put on a warmer sweater and turn down the thermostat
- (c) Seal up all the gaps and cracks with caulking
- (d) Upgrade your boiler, or heating system.

**Answer:** (b) Put on a warmer sweater and turn down the thermostat

**QU. 7B (5 points). Which of these things can you do yourself to make your home warmer, without much difficulty?**

- (a) Replace all your windows with tighter, more efficient windows
- (b) Seal up all the gaps and cracks with caulking
- (c) Upgrade your boiler, or heating system.
- (d) Add extra insulation to the roof

**Answer:** (b) Seal up all the gaps and cracks with caulking

**QU. 8 (10 points). If you eat beef, the cows that the beef came from will have produced methane gas, which is a powerful greenhouse gas. Which of these statements is true?**

- (a) All animals produce a lot of methane gas, so it doesn't really matter
- (b) If you become a vegetarian, you will also produce a lot of methane gas, so it won't make any difference if you eat less meat.
- (c) A typical family of beef eaters will be responsible for 1.3 tonnes of greenhouse gases from the methane from the cows that produced their beef in a year.
- (d) If you feed the cows "Beano", it will stop the methane gas.

**Answer:** (c)

Re: (a) It is cows that have four stomachs, and produce so much gas.

Re (b) Amusing, but false. Humans only have one stomach. And do meat-eaters never fart?

Re (d) Amusing, and partly true, but not enough to win the points. Scientists in Scotland are working to develop a special enzyme to feed to cows that might reduce the amount of methane that they produce.



**QU. 9** We're getting close to the end now. This is a question about the "stuff" that a typical North American family consumes in a year. It comes in 3 parts, each worth 5 points.

**QU. 9A (5 points).** Think about all the things that a typical North American buys and uses during a year. Now think about everything that is needed to gather the raw materials, make them, and ship them around. Now here's the question. When you add up all of the stone, cement, coal, minerals, oil, gas, wood, grass, and metals that are needed to do all this, how many tonnes of material do you think a typical North American uses in a year?

- (a) 2 tonnes
- (b) 20 tonnes
- (c) 13 tonnes
- (d) 28 tonnes

**Answer:** (b) 20 tonnes

**QU. 9B (5 points).** If everyone who lives on the Earth consumed the same amount of stuff that North Americans do, how long would it be before we ran out of the materials needed to make them?

- (a) 50 years
- (b) Never
- (c) 350 years
- (d) Yesterday

**Answer:** (d) Yesterday. "Ecological footprint" analysis shows that if everyone were to consume at the same rate that North Americans do, we would need 1.5 planets.

**QU. 9C (5 points).** Which of the following do you think is the most sensible way to make a smaller impact on the Earth, with all the stuff we consume?

(After the teams have decided, everyone will vote on each of the 4 options. The team that chose the response that wins the most votes wins the points. If both teams have the same answer, they get 5 points each. Everyone in the class who voted for the most popular answer wins 5 points.)

- (a) Try to buy everything using recycled materials
- (b) Stop consuming so much stuff, and live more simply
- (c) Don't worry about it. Humans have always been creative, so modern technology will find a substitute as soon as something runs out.
- (d) Persuade your parents to sell everything you don't really need as a family, and use the money to help you get a training or education so that you can do something that will make a difference.

This is all good food for discussion.



**QU. 10 (10 points)** The final question is about activism. It follows the words of the American anthropologist, Margaret Mead, who once said: “Never doubt that a small group of thoughtful, committed citizens can change the world. Indeed, it’s the only thing that ever has.”

**Which of the following statements do you think is a sensible response to the threat of global climate change in the Arctic?**

(After both teams have decided, there is a full class discussion, at the end of which, everyone votes on the 4 options. The team that chose the response that wins the most votes wins the points. If both teams have the same answer, they get 5 points each. Everyone in the class who voted for the most popular answer wins 5 points.)

- (a) All young people should write to the Prime Minister of Canada, and the Premiers of the Yukon, NWT and Nunavut, asking them to take more actions to protect the world, and especially the Arctic, from global climate change.
- (b) We should do something more dramatic that will win people’s attention, like fasting for a week, or holding a sit-in on the ice, before it melts in the summer.
- (c) These are stupid ideas. We should put our attention into getting a good education, so that we can learn how to develop and use the new technologies that don’t depend on fossil fuels.
- (d) It’s all too late, and nobody cares what’s happening up here in the North. Besides we’re too few to make a difference. We may as well just get on with life, and enjoy it while we can.

This is all good food for discussion.

**The Winning Team receives a big round of applause, and the teams join the rest of the class.**