

The Greenhouse Effect and Global Warming

Student Activity Sheet

Name _____ Date _____ Class _____

The greenhouse effect results from the heat energy of sunlight being absorbed by the Earth and molecules in the Earth's atmosphere. This energy is usually radiated back towards space. However, as we change the gases in the Earth's atmosphere as the results of everyday living, this energy is unable to leave the Earth's atmosphere and is trapped as heat. The heat causes a gradual warming of the air around the Earth. This warming is known as the *greenhouse effect*.

Some scientists are concerned that the heat in the Earth's atmosphere may be increasing to dangerous levels due to the greenhouse effect. Average global temperatures have been rising since the 1800s: the average temperature of the Earth has risen approximately 0.7°C or 1.2°F.

A warmer atmosphere may seem desirable to many people. However, significant warming could have many harmful effects. Lower heating costs could be offset by higher air conditioning costs. Areas that now grow most of the world's food might become too warm or too dry to grow crops. The areas that would become warmer, like Canada, do not have appropriate soil for growing crops. Lower water levels in lakes and streams would concentrate pollutants. Weather patterns may change with hurricanes probably hitting the coast farther north and with greater ferocity. Warmer temperatures would increase the volume of water in the oceans and possibly melt much of the ice in mountain glaciers and the Arctic and Antarctic ice caps. This would cause sea level to rise, causing flooding of the world's coastal cities, where one-third of the world's population lives. Protective barrier islands would disappear underwater, resulting in increased coastal erosion. For these and other related reasons, scientists are very concerned about the greenhouse effect.

Some scientists are not convinced that global warming, due to the greenhouse effect, is occurring at this time. They believe that if global warming is occurring, that it may not be due to human activities. These scientists point out that the Earth's average temperature has fluctuated since the Earth was formed. So they say that these temperature changes may be due to natural processes and there is nothing we can do about them. However, we do know that we have increased the atmospheric amounts of several compounds since the beginning of the Industrial Revolution.

Even if the Earth is going through a natural phase of global warming, humans may be increasing the degree of warming by the chemicals that they add to the air.

Four primary compounds are thought to be responsible for global warming. **Carbon dioxide** (CO₂) gas is thought to be responsible for 50 to 55 percent of the global warming trend. **Fossil fuel** combustion (the burning of coal, oil, gas, natural gas) and increased **deforestation** (the clearing away of forests to use the land for other purposes) are thought to be the main reasons for increased levels of carbon dioxide in our atmosphere. Trees and other plants need carbon dioxide to live, much as we humans need oxygen to live. Fewer trees means less CO₂ removed from the air. **Chlorofluorocarbons** (CFCs) are thought to be responsible for 25 percent of global warming. CFCs are used to make plastic foams (such as styrofoam) and aerosol propellants in addition to being used as refrigerants in air conditioners and refrigerators. **Methane** (CH₄) is indicated in approximately 12 percent of the global warming trend. It is produced by bacterial decay of organic matter and in the stomachs of cattle, sheep, termites, and other organisms. Some methane also comes from industry and other man-made sources. **Nitrous oxide** (N₂O) is responsible for about 6 percent of global warming. Nitrous oxide is produced as a byproduct of certain industrial processes, by microbial action on nitrogen fertilizers and livestock wastes, and from volcanic eruptions.

Regardless of whether global warming is occurring as a result of the greenhouse effect, most scientists agree that there are steps that we should take to reduce the amount of air pollutants that are thought to cause it. These steps would reduce air pollution and save energy at the very least. Some recommended things that we can do include: reducing the production of CFCs; reducing the use of fossil fuels; increasing the use of air pollution control devices; stopping deforestation; planting more trees; reducing water pollution; and slowing human population growth.

Objectives:

- Use **models** to generate data and to simulate what happens in the real world.
- Analyze and interpret data generated from the model.
- Apply knowledge of the greenhouse effect to change the behavior of society and individuals.

Materials:

Graph paper
Pencil or Pen

Data sheet
Colored pencils (student supplied)

Procedures

1. Your teacher will have a demonstration of the greenhouse effect set up in the front of the classroom. You will need to have your data sheet and something to write with so that you can record two temperatures every minute throughout the demonstration. Students will take turns writing the temperatures on the board as well.
2. The lights will be turned on for fifteen minutes and different students will help read the temperatures and record the data on the board. Someone will call out a temperature reading once a minute. Pay attention so you don't miss any, but if you do, get it from the data table on the board.
3. The lights will now be turned off for fifteen minutes and you'll see how the temperature changes. Make sure you record the data on your data table every minute for fifteen minutes except you will write in the part of the chart that says "lights off".
4. Take the data table you filled in and make a graph from the data. Plot the time on the horizontal (X) axis and the temperature on the vertical (Y) axis. Connect the data points to form a line showing how the temperature changed over time. Make sure you graph the "lights on" and "lights off" data. You can put both sets of data on one graph if you use a different color for each line and include a key explaining what each color is on your graph. For instance, you could make your "lights on" line red and the "lights off" line blue.
5. Answer the discussion questions.

Discussion Questions

1. The model in the demonstration simulated what happens on Earth during the greenhouse effect. Each of the elements in the model represented something on Earth. What did item's a)-d) represent?

<u>Model</u>	<u>Earth</u>
a) light from the lamp	a)
b) soil	b)
c) air in the box	c)
d) plastic wrap	d)

2. How was this demonstration a realistic model of the greenhouse effect?
3. How was this demonstration *not* a realistic model of the greenhouse effect?

4. In which of the boxes did the greatest temperature change occur? Explain why this happened.

5. What does the plastic wrap represent in this experiment and was it a good substitute for the real thing?

6. Where do these greenhouse gases come from?

CO₂:

N₂O:

CH₄:

CFC:

7. What effects do you think global warming may have on people's health?

8. What can we do to help control the amount of greenhouse gases emitted into the atmosphere and slow global warming?

Vocabulary

Greenhouse effect: The warming of the atmosphere due to the increased amounts of greenhouse gases such as carbon dioxide and nitrous oxides. These gases form a blanket over the Earth, trapping the energy or heat and preventing it from leaving the atmosphere. The atmosphere acts like a greenhouse.

Carbon dioxide: Although this gas is a normal part of atmosphere, it is thought to be responsible for 55-60% of the global warming trend. This is the gas we expel when we breathe and that green plants need for photosynthesis.

Fossil fuels: Coal, oil, and natural gas.

Deforestation: The removal of large areas of trees or forests by cutting or burning.

Chlorofluorocarbons: Compounds thought to be responsible for 25% of the global warming trend. Chlorofluorocarbons (CFCs) are used in air conditioners and refrigerators, as well as in making plastic foams, and in aerosol propellants.

Methane: This gas is thought to be responsible for approximately 12% of the global warming trend. It is produced by bacterial decay of organic matter and in the stomachs of cattle, sheep, termites, and other organisms. Some also comes from industry and other man-made sources.

Nitrous oxide: Gas that is responsible for about 6% of the global warming trend. It is produced by the microbial breakdown of nitrogen fertilizers and livestock wastes, from volcanic eruptions, and from industrial processes.

Model: A small example that imitates or mimics a real process or thing.

GREENHOUSE EFFECT DATA TABLE

MODEL WITHOUT LID

MODEL WITH LID

Light On		Light Off			Light On		Light Off	
Time (min)	Temp (°C)	Time (min)	Temp (°C)		Time (min)	Temp (°C)	Time (min)	Temp (°C)
1		1			1		1	
2		2			2		2	
3		3			3		3	
4		4			4		4	
5		5			5		5	
6		6			6		6	
7		7			7		7	
8		8			8		8	
9		9			9		9	
10		10			10		10	
11		11			11		11	
12		12			12		12	
13		13			13		13	
14		14			14		14	
15		15			15		15	

Teacher Strategies

Materials for Greenhouse Effect Demonstration:

- Two transparent boxes
- Two 200 Watt bulbs
- Graph paper
- Two thermometers
- Watch or a clock with a second hand (**Teacher supplied**)
- Potting soil (enough to create a 2-3 cm layer in both boxes) (**Teacher supplied**)
- Overhead transparency of greenhouse effect
- Student activity sheets (including copy of overhead transparency)-one per student
- Plastic wrap (enough to cover one box)
- Two lamps (**Teacher supplied**)
- One spray bottle filled with water
- Two cardboard thermometer stands

Preparation:

1. Prepare the transparent boxes by adding potting soil in a 2-3 cm deep layer. Rest the thermometer stand on the soil and place the thermometer on top of it. A thermometer stand can be easily made from cardboard but it should raise the thermometer above the soil and allow you to easily read the numbers. Lightly dampen the soil with a spray of water from the spray bottle. Cover one box with the plastic wrap.
2. Locate the lamps approximately 25 cm above the center of the top of the boxes.
3. Construct a data chart on the board similar to the one in the student activity sheets.

Instructional Strategies:

1. Provide students with background information on the greenhouse effect using the provided overhead transparency. Give students their copy of the overhead at this time and review where these greenhouse gases come from. Some review of graphing skills may also be necessary.
2. Inform the students that they will be using a model of the Earth to see how the greenhouse effect works. Turn on the lamps and have students individually record the temperature every minute for fifteen minutes on their data charts. As soon as fifteen minutes are up, turn off the lamp and keep recording the temperature every minute for another fifteen minutes as the surroundings cool. You may want to give each student a turn at reading the thermometer. Assign one student for each segment to be the time keeper.
3. Have students construct graphs from the data that they recorded. Use time on the horizontal axis and temperature on the vertical axis. You may want to have the students use one piece of

paper and set of axes and use colored pencils or crayons to differentiate between the covered box and the uncovered box.

Answers to Discussion Questions:

1. Make comparisons between this model and the global greenhouse effect:

- | | |
|-------------------|-------------------------------|
| a) light | a) sun |
| b) soil | b) crust or land of the Earth |
| c) air in the box | c) air in Earth's atmosphere |
| d) plastic wrap | d) greenhouse gases |

2. How was this demonstration a realistic model of the greenhouse effect?

This demonstration is a realistic model because it demonstrates how heat can be trapped in air when it is enclosed in a space, which is essential what is happening to our atmosphere.

3. How was this demonstration *not* a realistic model of the greenhouse effect?

This demonstration was not a realistic model of the greenhouse effect because it is much simpler than all the complex physical and chemical interrelationships that exist on the Earth.

4. In which of the boxes did the greatest temperature change occur?

The covered box.

5. Explain why this happened.

The plastic wrap acts as an insulator to trap air in the box. When the air is trapped in the box and heat is added, you are only heating or adding energy to the trapped air. There is no other air to exchange the heat with. Therefore, the temperature rises more quickly in the covered box.

6. What does the plastic wrap represent or model in this experiment?

The plastic wrap represents the greenhouse gases such as carbon dioxide, nitrous oxides, and sulfur dioxides.

7. Where do these greenhouse gases come from?

<i>carbon dioxide</i>	automobiles, deforestation (removes a large sink for carbon dioxide as plants use carbon dioxide to make their own food), fossil fuel combustion
<i>methane</i>	decaying organic (plant and animal) material from slashed and burned agriculture, farming (both animals and plants)

chlorofluorocarbons (CFCs) refrigerants, aerosols, air conditioning, plastic foams, solvents

nitrous oxide artificial nitrogen fertilizers, industry, microbes, and volcanoes

8. What effects do you think the global warming may have on people's health?

Answers should include ideas about heat stress related health problems, overcrowding health related problems, as well as the uncertainty about what will happen.

9. What can we do to help control the amount of greenhouse gases emitted into the atmosphere and slow global warming?

Answers should include reduction of dependency on the automobile, changing agricultural methods, and ways to control CFCs production.

Approximate time required: 45 to 60 minutes.

Target audience: Science.

Extensions:

Grades 4-6

1. Have students conduct research on heat-related illnesses and heat tolerance.
2. Take the class to an auto shop and have a mechanic show them how an emissions tester works for automobiles.
3. Invite a representative of a local air pollution agency to speak to the class about the greenhouse gases and their effects on the environment.
4. Invite a health care professional to come to class to speak about heat-related illnesses and the effects of overcrowding.

Grades 9-12

1. Have students try to construct their own model of the Earth to demonstrate the greenhouse effect—perhaps they want to include large bodies of water, like the oceans, in their models to see how this will effect temperature. Students could also attempt to grow plants in the soil to discover what effect they may have on the temperature.
2. Take the class to an auto shop and have a mechanic show them how an emissions tester works for automobiles.
3. Invite a representative of a local air pollution agency to speak to the class about the greenhouse gases and their effects on the environment.

4. Invite a health care professional to come to class to speak about heat-related illnesses and the effects of overcrowding.
5. Conduct experiment as written. Construct two boxes in the manner described. Cover one with plastic wrap that is already misted. In the other box place small plants at irregular intervals (mosses, small houseplants, tiny ferns). Create a depression in one area, approximately 2" in diameter, and line with plastic wrap and fill 2/3 with water. Place small Legos™ or wooden blocks at irregular intervals to represent homes and businesses. Mist the soil. Cover this box with plastic wrap. Place both boxes under the lamps. Record temperature changes over time. Obtain an empty transparent box. Fill with 1/4 inch of sand over the entire bottom. Add 3.5% salt solution (35 g of NaCl in 1000 ml of distilled water) until the salt solution reaches half of the box height. Place thermometer in the water. Cover with plastic wrap. Have students collect and record 3 sets of data; one for land mass with plants, pond and buildings, one for bare soil, one for ocean. This can be repeated for sand alone.

Questions

1. Each of the models corresponds to what type of earth area?
2. In which box does the greenhouse effect cause the greatest increase in temperature? Why?
3. What method(s) of heat transfer are occurring in the plastic-covered boxes? Explain.
4. What are some of the laws that currently exist in the U.S. regulating greenhouse gases, air quality? Do you think these laws are effective? What laws exist in other industrialized/non-industrialized nations?

References:

- Carle, Mark. A., Mickey Sarquis, and Louise Mary Nolan. 1991. *Physical Science: The Challenge of Discovery*. D.C. Heath and Company, Lexington, Massachusetts.
- Christensen, John W. 1991. *Global Science Laboratory Manual*. Kendall/Hunt Publishing Company, Dubuque, Iowa.
- Hocking, Colin, et al. 1990. *Global Warming and the Greenhouse Effect*. Lawrence Hall of Science, University of California at Berkeley, Berkeley, California.
- Miller, Tyler G. 1990. *Living in the Environment*. Wadsworth Publishing Co., Belmont, California.
- Roa, Michael L. 1993. *Environmental Science Activities Kit*. The Center for applied Research in Education, Professional Publishing, West Nyack, New York.