

ACTIVITY 15: GLOBAL WARMING

Activity Summary

Students use plastic two-liter bottles to model the “greenhouse effect” or global warming.

Introduction

The “greenhouse effect” results from changes in sunlight as it passes through the atmosphere, is absorbed by the earth and molecules in the atmosphere, and is radiated back toward space. As the light is changed to infrared energy wavelengths (heat), it is absorbed by water vapor and a variety of “greenhouse gases.” Many scientists fear that if these greenhouse gases increase, less heat will be radiated into space, and Earth will become warmer. This warming of Earth could have a variety of harmful results, as discussed in the Student Background Information sheet (15.1).

The topic of global warming is one about which many students have heard, but about which there is great uncertainty in the scientific community. Some scientists point to measured increases in average annual temperatures as indicators of a general warming trend that is caused largely by human activities. Others say that the evidence is inconclusive for a variety of reasons. It may be a normal fluctuation that is not significantly affected by human activities and about which humans can do little. The validity of the temperature measurements themselves is sometimes questioned because of changes in the local areas where the data have been collected for many years.

This uncertainty within the scientific community affords us a chance to make decisions based on judgment. Is it better to continue spewing carbon dioxide and other greenhouse gases into the atmosphere and hope that those who are concerned about a “greenhouse effect” are wrong, or is it better to take steps to reduce the production of greenhouse gases and hope that we are not too late? Should we not err on the side of safety?

This activity allows students to use a model to simulate what happens in a greenhouse and may be happening in our environment. The sides of the 2-liter bottle and the plastic “lid” prevent the heated air from escaping into the environment, thus causing the air inside the bottle to become warmer faster than that in the “control,” which has shorter sides and no lid. It is important for students to understand that this is a model of what may be happening. Scientists use models to try to understand phenomena that are difficult to test in the laboratory or in nature because they are too small, too far away, too large, or take too long to happen. While models, including computer models, are not perfect, they can be useful in understanding a variety of phenomena.

Grouping

Teams of 2 students.

Time

45–55 minutes

Anticipated Outcomes

The students will:

- increase their understanding of the conversion of light energy to heat energy.
- increase their understanding of the “greenhouse effect.”
- increase their willingness to make choices that might help reduce air pollution.
- increase their understanding of the use of models, hypotheses, and controls in science.

Materials

—Photocopied student pages:

- 15.1 Global Warming: Background Information (one per student)
- 15.2 Global Warming: Instructions and Data (one per team)
- 15.3 Global Warming: Questions (one per student)

—Per team of 2 students:

- 2 clear plastic 2-liter bottles
- 1 plastic wrap or plastic bag with which to cover the “greenhouses”
- string, tape, or rubber bands with which to hold the plastic in place
- 2 thermometers (preferably the 6" long metal, plastic, or cardboard-backed type)
- 2 pieces of thin cardboard, about 2" × 2" (tagboard or halves of a 3" × 5" card)
- plastic ruler
- 2 rocks, approximately 2" in diameter, clean, dry, and of the same type
- 1 utility knife or single-edged razor blade (if you are having them cut the top off the bottles)
- masking tape

—If doing Extension activity 1:

- ice
- soil
- sand
- water
- grass/sod

—If doing the activity indoors, per team of 2 students:

- a light source such as a 100-watt (or more) bulb in a clip-on socket attached to a 2" × 4" × 12" board
- extension cords as needed

Vocabulary

chlorofluorocarbons
greenhouse effect

control
model

global warming
photosynthesis

Procedure

1. Using masking tape, attach (or have the students attach) the thermometers to the inside of the bottles.
2. Tape the small cardboard pieces over the thermometer's bulb so that it is not exposed directly to the rays of the sun, or not exposed to the light if the activity is to be done inside. The bottom of the thermometer should be about 2" above the bottom of the bottle. If there are portions of the bottle's label remaining, the thermometer should be attached next to the remaining label so that the label does not interfere with incoming light.
3. A dry, clean rock (or other weight) should be placed in the bottom of each bottle to keep it from tipping or being blown over.
4. The taller bottle should be covered with clear plastic held in place with string or a rubber band. This is the "greenhouse." The short bottle should remain uncovered. This is a control. (Since we are testing the effect of the plastic cover and sides, both the sides and cover need to be absent in the control.)
5. On the data table (15.2), have the students record the starting air temperature in each bottle.
6. Have the students set their bottles in open sunlight, with the thermometers facing away from the sun.
7. The students should record the temperature inside of the bottles every two minutes for 20–30 minutes.
8. The temperatures should then be graphed.

9. After discussing the results of this experiment, have the students read the Background Information sheet (15.1) and discuss global warming.
10. Extension 1 is highly recommended as it provides good practice in setting up experimental controls, hypothesizing, and collecting and interpreting data.

Discussion

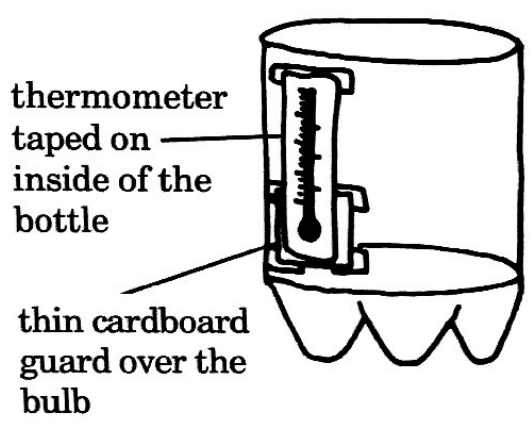
1. How is this model like and unlike the real atmosphere and global warming?
2. What was the purpose of the short bottle without the plastic cover?
3. Since not all scientists agree that we have evidence for global warming, should anything be done now to reduce the so-called “greenhouse gases”?
4. What can be done to reduce the production of greenhouse gases?

15.2 Global Warming: Instructions

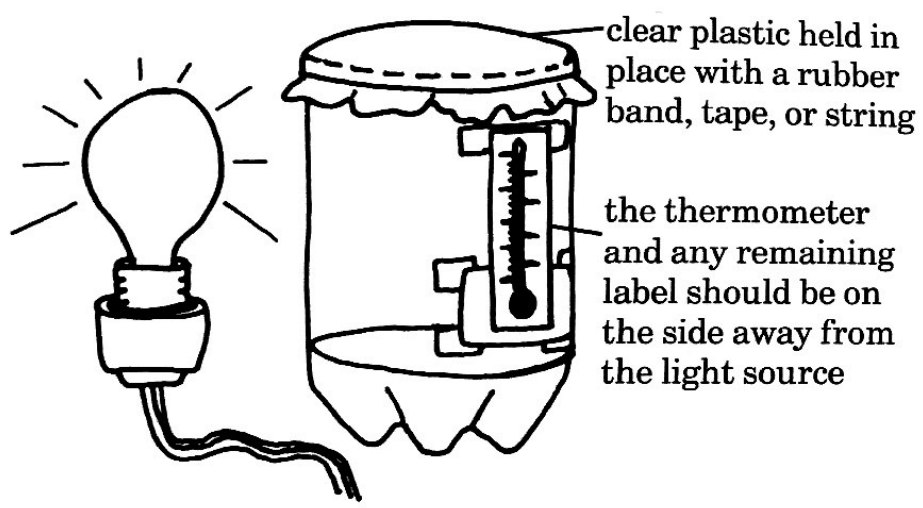
In this activity, you will use a model to learn about the “greenhouse effect.” First prepare a “greenhouse” and a “control” as instructed by your teacher. (See the diagram below.)

You will either set your greenhouse and the control in the sun or will place a light bulb between them as a source of light energy. As the light passes through the plastic and is absorbed by the contents of the bottles (air and a rock), it is changed to heat energy. Heat energy does not easily pass through the bottle, so it is trapped inside. The plastic bottle is a model of the greenhouse gases that some scientists fear are causing the earth to get warmer.

CONTROL BOTTLE



“GREENHOUSE” BOTTLE



When you set up your experiment, be sure to do the following:

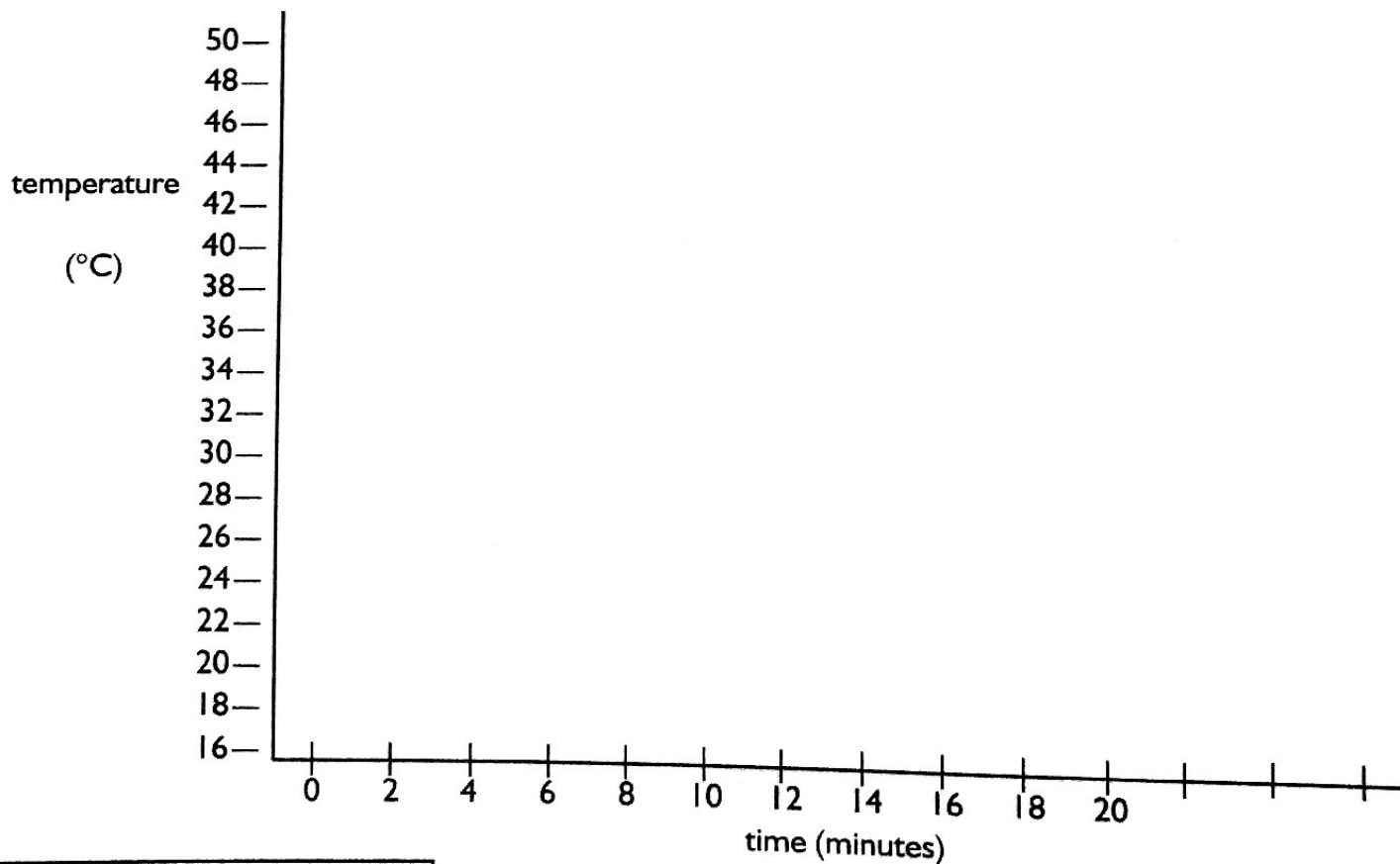
1. Use a piece of cardboard to shield the thermometer bulb from the light.
2. Be sure that both the thermometer and any of the label that has not been removed are on the side away from the light source.
3. Be sure to place your bottles where they will not be disturbed and where they will not be shaded before the data have been collected.
4. If you are using a bulb as a light source, be sure that the bottles are both the same distance (about 2 cm) from the light bulb and that the thermometers are oriented in the same position relative to the light bulb.
5. Read the thermometers every two minutes. Try to take your readings as close to the same time as possible. Always read the same thermometer first.
6. Accurately record your data on the data table.
7. Graph your data. Be sure to use the “key” on the graph to show which graph is the control data and which is the “greenhouse” bottle data.

15.2 Global Warming: Data

Use the table below to record the temperatures of both thermometers every two minutes. Be sure to record them as close to the same time as possible. Be careful not to shade the bottles when reading the thermometers.

TIME	BOTTLE #1 (control)	BOTTLE #2 ("greenhouse")	TIME	BOTTLE #1	BOTTLE #2
0 (start)	_____°C	_____°C	10 min.	_____°C	_____°C
2 min.	_____°C	_____°C	12 min.	_____°C	_____°C
4 min.	_____°C	_____°C	14 min.	_____°C	_____°C
6 min.	_____°C	_____°C	16 min.	_____°C	_____°C
8 min.	_____°C	_____°C	18 min.	_____°C	_____°C
			20 min.	_____°C	_____°C

Record the temperatures from both bottles on the graph below, connecting the points with lines. Either use different colors to record the temperatures from the different bottles, or use a solid line for the control and a dashed line for the "greenhouse" bottle. Identify the colors or symbols on the "KEY" box.



KEY:
 control bottle:
 "greenhouse" bottle:

15.3 Global Warming: Questions

1. Was there a difference in the warming rate of the control bottle and the greenhouse bottle? If so, describe the process that took place.

2. List three "greenhouse gases," their sources, and at least one way that they could be reduced.

3. What would be some likely consequences if the scientists who say that humans are significantly increasing global warming are correct and we do not take steps to halt it?

4. What would be some likely consequences if the scientists who say that humans are not significantly increasing global warming are correct and we do take steps to halt it?

5. Which do you think we should do: Take immediate action to stop any possible human-caused greenhouse effect or wait another 5–10 years while more studies are done? Why?

6. Why do scientists sometimes use "models"?

7. What is the purpose of the "control" bottle in the model?
