

MAKING A GREENHOUSE

OVERVIEW

The students will observe the greenhouse effect using 2-liter plastic bottles, soil, and water. They will measure temperature changes as well as the effects of soil dampness.

CONCEPTS

- In a *greenhouse*, visible light (e.g., from the Sun) easily penetrates glass or plastic walls, but heat (in the form of *infrared radiation*) does not.
- The *greenhouse effect* refers to the physical process by which atmospheric gases allow sunlight to pass through, but also absorb infrared radiation from Earth's surface. Thus the atmosphere acts like a heat-trapping blanket. Life as we know it could not exist on Earth without the warming produced by the greenhouse effect.
- *Global warming* refers to the gradual increase of the Earth's average temperature.
- Scientists debate whether the average temperature of the Earth is increasing, and if human activity is the principal cause.



MATERIALS

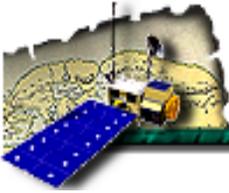
- 2 Clear plastic 2-liter bottles per team of students
- Plastic wrap or clear plastic bags to cover the "greenhouses"
- String or rubber bands to hold the plastic in place
- 2 Thermometers per team
- Two 2"x 2" pieces of thin cardboard
- Soil
- Ice cubes
- Water
- Plastic rulers
- Masking tape
- Utility knife or saw for cutting the plastic bottles
- Clip-on light source with at least a 100 watt bulb (only if you are doing the activity indoors) per team of students

PREPARATION

Ask each student to bring a 2-liter bottle to class. You could also try to obtain them from a recycling center. You can cut the bottles before class or have the students cut them. Cut half of the bottles near the shoulder and the other half about 4 inches from the bottom. The short bottles will be used as controls for the experiment, because they are shorter they will not trap air as well.

If you plan to do this activity on a cloudy day, you will need a light/heat source. You can use a 100+ watt bulb in a clip-on lamp attached to a stand.

It should take about 15 minutes to set up the greenhouses. You will need more time if the students cut their own bottles. You must let the bottles sit in direct sunlight for 30 to 50 minutes, depending on weather conditions. Allow 50 minutes if you are using the light bulb indoors. Plan on 30 minutes to record and



discuss observations.

The students can create any setup that will test their *hypothesis*. You might want to have a sample setup

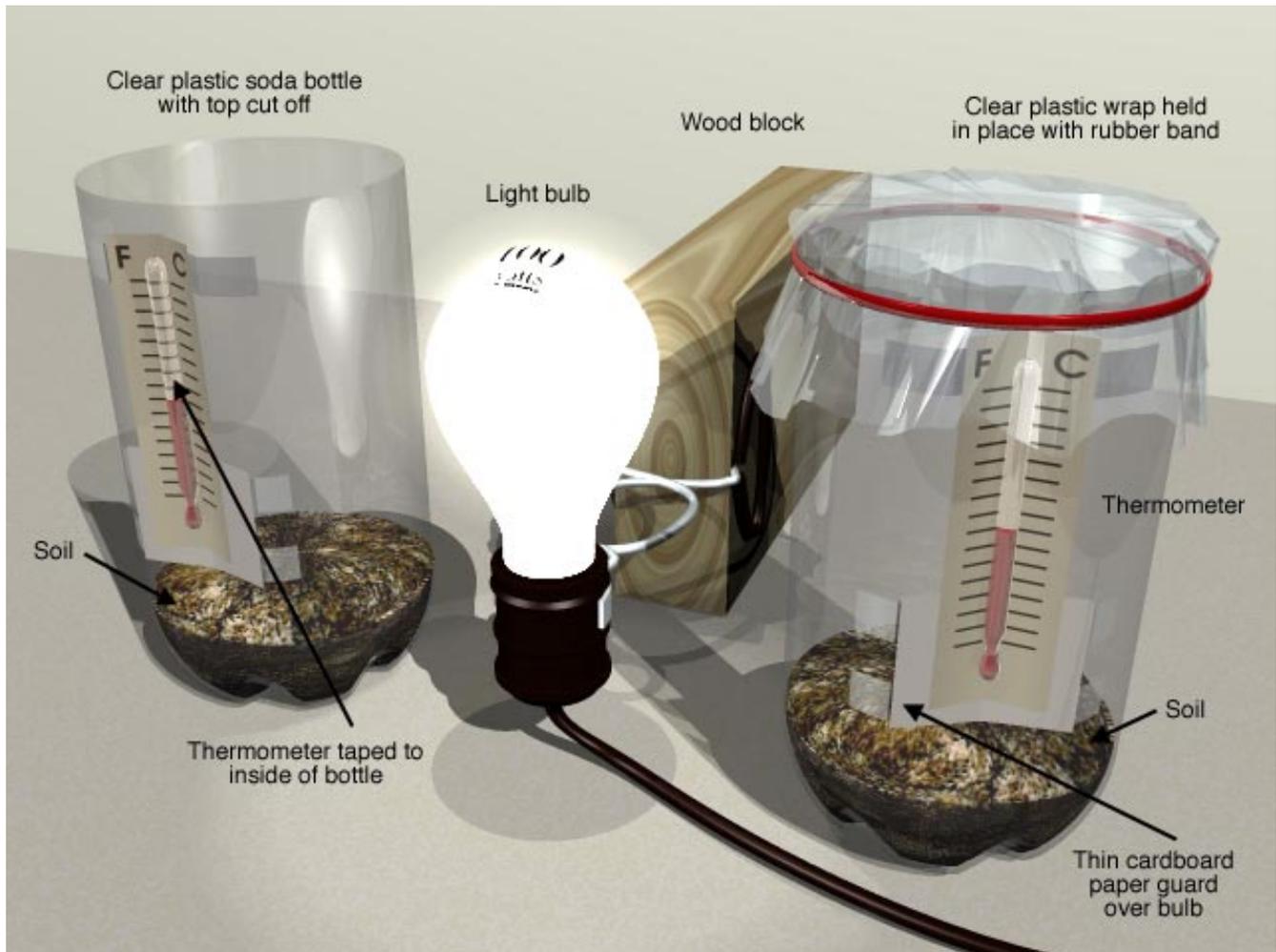


Figure 1. **Sample experimental setup.**

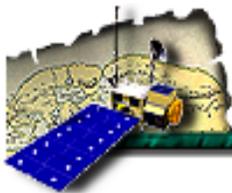
to show the students. It can look something like this:

There are several suggestions for experiments. For all of the experiments, make sure the bottles are in a place where they will remain in the direct sunlight for the duration of the experiment. Also make sure that the thermometers are facing the same direction relative to the light source.

For testing the effect with damp soil, make sure to use the same type and amount of soil in both the experimental and control bottle.

For testing the effect on water temperature, make sure to use the same amount of water in the bottom of each bottle. The thermometer bulb must extend into the water to the same depth.

For testing the effect on ice water, start with about 3 inches of water in the bottom of each bottle. Mark the water level on the outside of each bottle with a permanent marker. Add 6 - 12 ice cubes to each bottle. In this experiment change in the water level is more important than the temperature difference. Continue the experiment until all the ice is melted.



Visit to an Ocean Planet



PROCEDURE

Engagement

The Earth's greenhouse effect is a natural consequence of the chemical makeup of its *atmosphere*. If it were not for the greenhouse effect, life as we know it could not exist on Earth: it would be too cold. Our atmosphere is made mostly of nitrogen and oxygen, but also contains several other gases. These include carbon dioxide, methane, nitrous oxide, water vapor and ozone, which are known as *greenhouse gases*.

Greenhouse gases are released naturally through geologic processes and the metabolic activity of living things. However, there is an ongoing debate over human effects on Earth's global climate. Human industrial activity on the planet has increased the quantities of greenhouse gases through agriculture, manufacturing, power generation, and engines used for transportation. Key questions include: Is the average temperature of Earth increasing? Does the presence of human beings contribute to global warming? If the temperature of Earth does become warmer, how will it affect us?

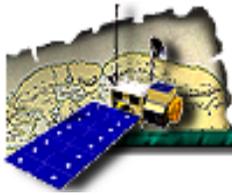
Activity

1. After discussing the greenhouse effect and explaining the model that the students will set up, spend several minutes brainstorming for ways to test the effects of the greenhouse effect on the following: air temperature alone; air temperature above soil; soil temperature; water temperature; and polar ice caps.
2. Give each team of students an equipment tray with the materials listed above. Have teams of students select one of the effects from the list in Step 1 to investigate, and design an experiment using the equipment on the tray. Each team should create a control experiment using the shorter bottle without the plastic cover. The student-designed experiment should include a *hypothesis*, a procedure (including a sketch) and a data recording table, including appropriate units of measure.
3. When the experiments have been approved, the students will setup and complete their experiment. They should let the bottles sit in direct sunlight for 30 to 50 minutes and record their observations, before, during and after the period the bottles are in the sunlight.
4. Have each team report on their setup and findings. Record their data on the board or on an overhead projector transparency. List their hypotheses and whether their hypotheses were confirmed by the experiment. Were there any experimental errors? What other experiments do the data suggest?
5. What might happen if we continue to release greenhouse gases into the atmosphere?

Explanation

In this activity, the bottles are greenhouses. The temperature reflects the radiative properties and effective insulating ability of the plastic wrap that covers the top of the bottles. This is a simple model of the greenhouse effect that is analogous to the atmosphere's ability to trap heat.

When the Sun's energy reaches Earth's atmosphere, some of it is reflected back into space by the denser layers of the atmosphere, particulate matter, cloud tops, and the reflective properties of Earth's surface, oceans and ice caps. The remaining energy passes through the layer of greenhouse gases and is absorbed by the surface of Earth (land and water). The land and water eventually release some of that energy as infrared radiation. When infrared radiation encounters greenhouse gases, much of it is absorbed and re-radiated. Some of it is radiated back to the ground and oceans which absorb the re-radiated energy. If it were not for the insulating properties of the atmospheric greenhouse effect, life as we know it would not be possible on Earth.



Visit to an Ocean Planet



Global warming refers to the gradual warming of Earth's overall (average) temperature. Scientists are using computer models to predict increases in overall temperature based on levels of carbon dioxide in the atmosphere. Data from monitoring stations show that there has been an increase in the levels of carbon dioxide, as well as other greenhouse gases in recent years (see activity *Analyzing Greenhouse Gases and Global Temperature Data Over Time*). One challenge in understanding these data is that past natural changes have been very large (see *Climate - Process and Change*), so sorting out human-caused changes from natural ones is difficult. Scientists wonder whether we are in the process of creating a catastrophic condition or are merely experiencing part of a long, natural, self-regulating cycle.

EXTENSION

You may wish to try a few variations of the experiment to extend the lesson. The students might test other variables, such as wet versus dry soil, different kinds or colors of soil, evaporation rates of water from soil, and salt water versus fresh water. The students can also test the effect of using green rather than clear bottles or of changing the amount of light entering the bottle.

You can also have your students research and debate the data surrounding the issue of global warming. You might wish to conduct a simulated World Climate Conference to discuss the issue of global warming. Try to resolve these key questions: Is global warming occurring? If so, is it caused by natural events or human activities? What, if anything, should be done about it?

LINKS TO RELATED CD ACTIVITIES, IMAGES, AND MOVIES

Image of *Earth's greenhouse cycle*

Activity *Analyzing Greenhouse Gases and Global Temperature Data Over Time*

VOCABULARY

atmosphere

global warming

greenhouse

greenhouse effect

greenhouses gas

hypothesis

infrared radiation

SOURCE

Adapted from GEMS, *Global Warming*