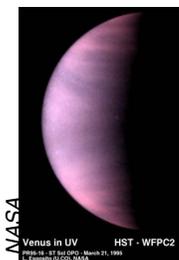


Cosmic Chemistry: Planetary Diversity

Hot and Cold Running Planets

TEACHER GUIDE

BACKGROUND INFORMATION



Venus



Earth

The atmospheres of several of the planets, especially Venus and Earth, contain substances such as carbon dioxide and water that have a direct influence on the planets' equilibrium temperatures. This effect is often called the greenhouse effect. Students probably are aware of this term because it has been a topic of intense debate over the past few years, largely because of concerns that the Earth's temperature is increasing as a result of expanding levels of greenhouse gases in our atmosphere.

In this activity, the greenhouse effect will be simulated in a very simple fashion. Students will demonstrate that under greenhouse conditions, the temperature of an atmosphere is indeed raised to higher levels than under conditions where the greenhouse effect is not operative.

NATIONAL SCIENCE STANDARDS ADDRESSED

Grades 5-8

Science As Inquiry

Abilities necessary to do scientific inquiry
 Understandings about scientific inquiry

Physical Science

Properties and changes of properties in matter
 Transfer of energy
 Interactions of matter and energy

Grades 9-12

Science As Inquiry

Abilities necessary to do scientific inquiry
 Understandings about scientific inquiry

Physical Science

Properties and changes of properties in matter
 Transfer of energy
 Interactions of matter and energy

Earth and Space Science

Energy in the Earth system

(View a full text of the [National Science Education Standards](#).)

MATERIALS

For each student

- Copy of [Student Activity, "Hot and Cold Running Planets"](#)
- Copy of [Student Text, "The Greenhouse Effect"](#)

For each group of students:

- One or two thermometers (depending on the experimental setup selected) or computer probe wear
- Graph paper
- Clear glass plates or plastic wrap for covering the container(s)

- Containers such as 1 liter beakers. (Small aquaria can be used quite effectively as well, and are recommended.)
- Light bulb and socket. A flexible light fixture equipped with a 120-watt floodlight is recommended.
- Small piece of card stock for shading the thermometer(s).
- Tape
- Black construction paper (optional).

PROCEDURE

1. Before class make copies of the following:
Student Text "Greenhouse Effect"
Student Activity "Hot and Cold Running Planets"
2. Distribute copies of the Student Activity and Student Text.
3. This activity may be conducted by the entire class as a group, or if you wish you can divide the class up into small teams and have each team conduct the investigation independently. The remainder of this section will be written as if it is being conducted by the class as a whole, with designated groups of class members having specific responsibilities. Ask for a small group of volunteers to serve as the construction team for the class. Ask another group to serve as data recorders and another group to serve as discussion leaders.
4. Set the scene by giving the discussion leaders the task of finding reasonably current articles in newspapers, reference books, news magazines, or scientific publications that deal with the greenhouse effect. They should work on this at least a week before the experimental data are to be collected for this activity. Then they should make an oral presentation to the class that focuses on the greenhouse effect as it applies to contemporary societal problems (see questions in student activity).
5. Direct the construction team to assemble, with your assistance, the necessary items for setting up the simulated greenhouse effect experimental activity after deciding what type of container(s) they will use. The sun is simulated with the floodlight, which should be located about 15 cm. above the containers. Measurements are to be made both with an open container and with another one covered with plastic wrap or glass. It should take about 4 hours for the temperature in the containers to reach equilibrium, depending on the air currents in the room, the size of the containers, and so on. Make sure the students tape the thermometers in place within the containers. Include a method for shading the thermometers from the direct radiation of the floodlight, while at the same time allowing free air circulation around the thermometer bulb. Better results may be obtained if the students place the containers on a dark surface such as black construction paper. The construction team should set up the actual experimental apparatus following the presentation by the discussion leaders.
6. Now, the data-recording group can record temperature vs. time data as obtained from the apparatus. WARN the group that the floodlight is very hot and that they should be careful while making measurements not to touch it. Designate a location for the group to display the data obtained in the experiment in a graphical format.
7. Either you or the discussion leaders should lead the follow-up session. If you assign the follow-up session to the discussion leaders, you may wish to hand them copies of these questions to guide the student discussion.



Focus the follow-up session on the following types of questions:

- a) What did the plastic wrap (or glass plate) represent in this simulation?
- b) Why was plastic wrap (or a glass plate) used instead of an actual greenhouse gas to simulate the greenhouse effect?
- c) Why was the final temperature higher when the container was covered?
- d) Why did the temperature in the covered container not continue to rise to still higher levels than it did? In other words, why did the temperature level out?
- e) What effect would have been observed if the room started out being ten degrees cooler at the beginning of the experiment?
- f) Was the rate of heating appreciably different when the container was covered?

- g) What would have happened in this experiment if an infrared lamp, instead of a floodlight, were used as a light source?
- h) Why was it necessary to shade the thermometer?
- i) Was thermal energy transferred from the lamp to the contents of the container by radiation, convection, or conduction?
- j) How might this experiment have been modified to simulate the effect of clouds in the Earth's atmosphere?