

Greenhouse Gas Modeling Activity

Strand Earth and Space Systems

Topic Investigating the atmosphere

Primary SOL ES.11 The student will investigate and understand the origin and evolution of the atmosphere and the interrelationship of geologic processes, biologic processes, and human activities on its composition and dynamics. Key concepts include

- c) atmospheric regulation mechanisms including the effects of density differences and energy transfer;
- d) potential changes to the atmosphere and climate due to human, biologic, and geologic activity.

Related SOL ES.1 The student will plan and conduct investigations in which

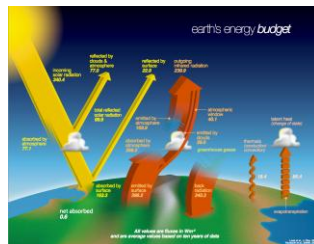
- c) scales, diagrams, charts, graphs, tables, imagery, models, and profiles are constructed and interpreted.

Background Information

A greenhouse gas (sometimes abbreviated GHG) is a gas in the atmosphere that absorbs and emits radiation within the thermal infrared range. This process is the fundamental cause of the greenhouse effect. The primary greenhouse gases in Earth's atmosphere are water vapor, carbon dioxide, methane, nitrous oxide, and ozone. In the Solar System, the atmospheres of Venus, Mars, and Titan also contain gases that cause greenhouse effects. Greenhouse gases greatly affect the temperature of Earth; without them, Earth's surface temperature would likely be colder than present.

A commonly held misconception about greenhouse gases is that they reflect heat back to Earth. Greenhouse gases do not reflect heat. They retain or absorb heat that radiates off of Earth's surface and reradiate it back to Earth and to space. Most of the heat, in fact, returns back to space. Students may also conclude that the gases absorb heat when sunlight first penetrates the atmosphere from the Sun, but this is not the case except for some like ozone, which has some absorption in the ultraviolet and in the infrared wavelengths. Earth first absorbs the visible radiation from the Sun, which is then converted to heat, and this heat radiates out to the atmosphere, where the greenhouse gases then absorb some of the heat. Be sure to check for student understanding of these concepts.

The balance between the energy coming into a system compared to the energy going out of that system.



[Earth's Energy Budget \(PDF\)](#)

Materials

- 2 lamps with 200-watt bulbs
- 2 terrariums or large glass jars
- 2 temperature probes or thermometers
- Plastic wrap
- Watch or a clock with a second hand
- Dark potting soil (for 2- to 3-centimeter layers in each jar)
- One spray bottle filled with water (this could be shared amongst groups)
- Ruler or tape measure
- Greenhouse Modeling Activity worksheet

Vocabulary

greenhouse gas,

Student/Teacher Actions (what students and teachers should be doing to facilitate learning)

Introduction

1. Draw on students' prior knowledge or experience with atmosphere's role in affecting Earth's surface temperature by asking the following questions to engage students.
 - Imagine it is winter, and you have been having sunny, clear days. Now, one morning you wake up, and look out the window to see that it is very cloudy. How do you think the temperature outside will compare to yesterday's?
 - Have you had an experience like this before? What have you observed?
2. Review the role of the atmosphere in a planet's temperature and the properties and characteristics of molecules which relate to the role of the atmosphere.
 - What factors determine the surface temperature of a planet?
 - How does Earth's atmosphere affect the planet's temperature?
3. Introduce the following questions for the students to consider. What are greenhouse gases? How do the unique properties of greenhouse gases affect a planet and human life?

Procedure – Radiant Heat Activity

1. Ask the students to describe the relationship between light and heat.
2. Place students in small groups. Give the groups a lamp and have them use their hands as the objects to be heated by the light.
3. Have the students predict what will happen to their hands if a strong light source would shine on it for a long period of time.
4. Students should test their predictions with the light source and record their observations. Remind students that bulbs will become hot and they should not touch the bulb or get too near the bulb.
5. Have students predict if heat can be transferred to your cheek even if your hand didn't touch your cheek.

6. Have students carefully heat up one student's hand with the light and test for heat radiation with their cheeks (students should not touch the hand to their cheek). Students record their observations.
7. Ask the students to think of the light source as the sun and your hand as Earth. Ask them, what happens when the heat from the sun reaches Earth? Ask them to describe what happens when heat from the sun reaches Earth.

Procedure – Greenhouse Modeling

1. Cover the bottom of two terrariums or glass jars with 2 to 3 centimeters of dark soil.
2. Place a temperature probe or thermometer inside each terrarium or glass jar. If a thermometer is being used for the investigation, consider using thermometer stands that can be made from cardboard so that the thermometers are raised above the soil and allow you to easily read the numbers.
3. Lightly dampen the soil with a spray of water from the spray bottle.
4. Cover one terrarium or glass jar with plastic wrap.
5. Locate a lamp approximately 25 centimeters above the center of the top of each box.
6. Record the temperature of the temperature probes or thermometers on the data charts.
7. Record the temperature of each terrarium or jar every minute for 15 minutes.
8. Turn the light off for fifteen minutes. Record the data on your data table every minute for 15 minutes.
9. Graph both sets of data.
10. Respond to the questions on the Greenhouse Modeling Activity worksheet.

Assessment

- **Questions**
 - Answer questions in Greenhouse Modeling Activity.
- **Journal/Writing Prompts**
 - Have students write a persuasive essay using the information they collected during the Greenhouse Modeling activity.

Extensions and Connections (for all students)

- Research and report on global warming. Is it happening? How are people responding to it? What other gases are greenhouse gases? What is causing an increase in carbon dioxide levels? What new technologies can help decrease carbon dioxide levels?
- Give students a more open-ended version of the greenhouse modeling activity by providing a variety of different materials and having students design and test different models. Have them draw conclusions about which results in the best model show how the greenhouse effect works.

Strategies for Differentiation

- Have the students participate in creating a class data table to mimic multiple trials and statistical data analysis.
- Have students use a spreadsheet rather than the worksheet to record data.

Greenhouse Modeling Activity

Name _____ Class/Period _____

Prediction:

What will happen to your hand if you shine a strong light source on it for a period of time?

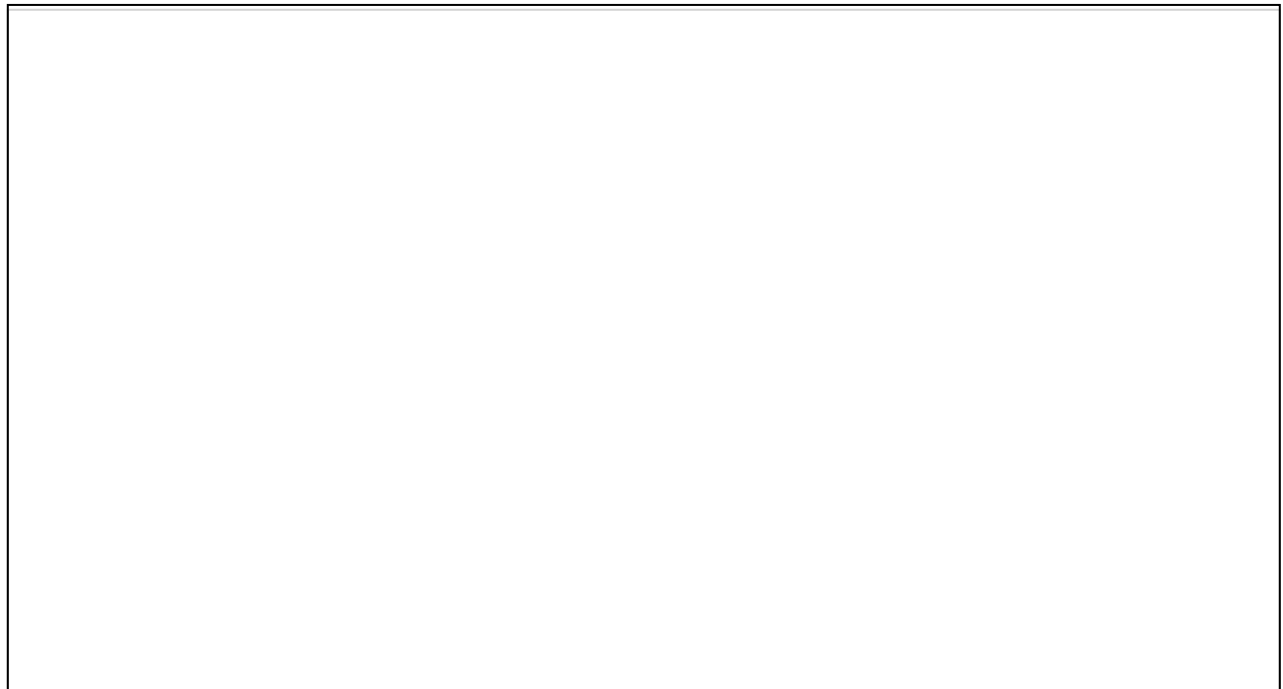
Summary of Observations:

Radiant Heat Activity

Prediction:

Could the heat from your hand be transferred to your cheek even if your hand was not touching your cheek?

Describe what happens when heat from the Sun reaches Earth. Draw a picture of what happens to the Earth.



Greenhouse Modeling Investigation

Materials:

- 2 lamps with 200-watt bulbs
- 2 terrariums or large glass jars
- 2 temperature probes or thermometers
- Plastic wrap
- Watch or a clock with a second hand
- Dark potting soil (for 2- to 3-centimeter layers in each jar)
- One spray bottle filled with water (this could be shared amongst groups)
- Ruler or tape measure
- Spreadsheet/graphing software (optional)

Procedure:

1. Cover the bottom of two terrariums or glass jars with 2 to 3 centimeters of dark soil.
2. Place a temperature probe or thermometer inside each terrarium or glass jar. If a thermometer is being used for the investigation, consider using thermometer stands that can be made from cardboard so that the thermometers are raised above the soil and allow you to easily read the numbers.
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9. Graph both sets of data.
10. Respond to the questions on the Greenhouse Modeling Activity worksheet.

Name _____ Class/Period _____

Greenhouse Gases Modeling Chart							
Model without Plastic Wrap				Model with Plastic Wrap			
Original temperature:				Original temperature:			
Light On		Light Off		Light On		Light Off	
Minute	Temperature	Minute	Temperature	Minute	Temperature	Minute	Temperature

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Questions

What is the difference between the two graphs? Why?

What do the graphs tell us about how greenhouse gases affect temperature?

The models simulate a planet with greenhouse gases and without greenhouse gases. What does each part represent (lamp light, soil, air in the container, and the plastic wrap)?

How was this a realistic model of the greenhouse effect?

How was this NOT a realistic model of the greenhouse effect?

Draw a picture of how CO₂ and other gases affect temperature. Explain your drawing.

