Greenhouse Effect Laboratory Guide

Driving Question: What impact does the greenhouse effect have on atmospheric temperature?

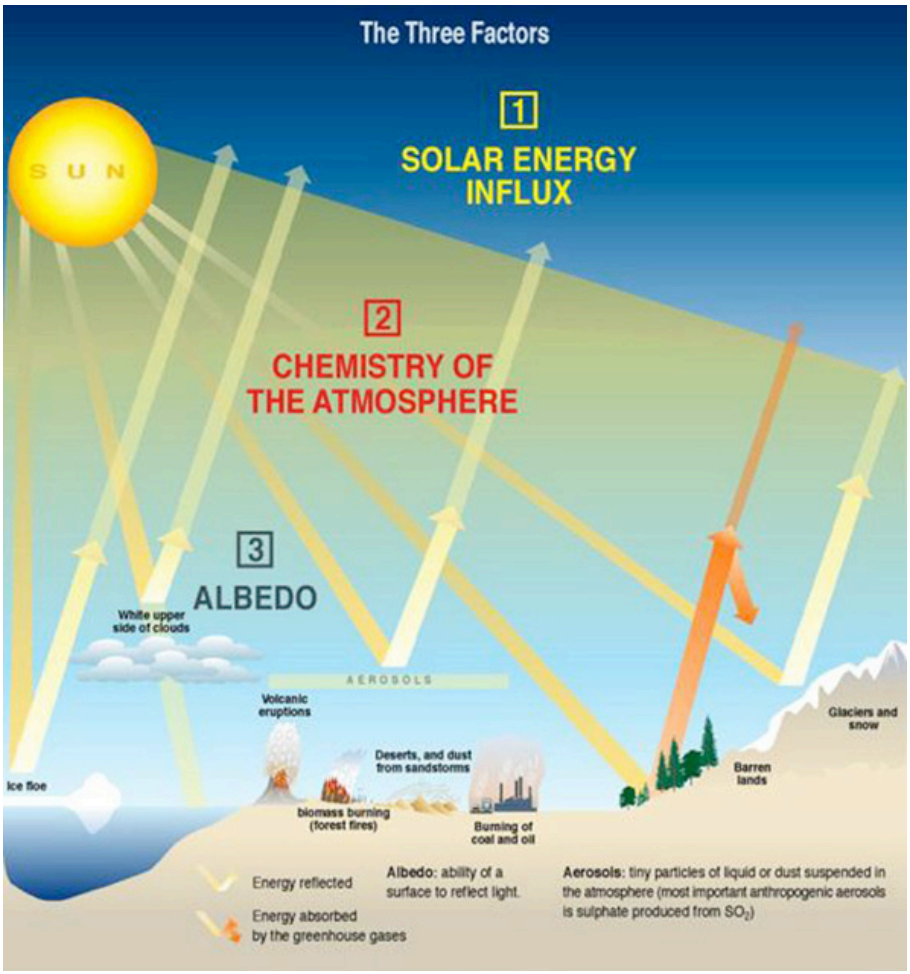
In this activity you will:

1. Understand the importance of greenhouse gases in our atmosphere.
2. Understand that excess CO_2 intensifies the greenhouse effect.

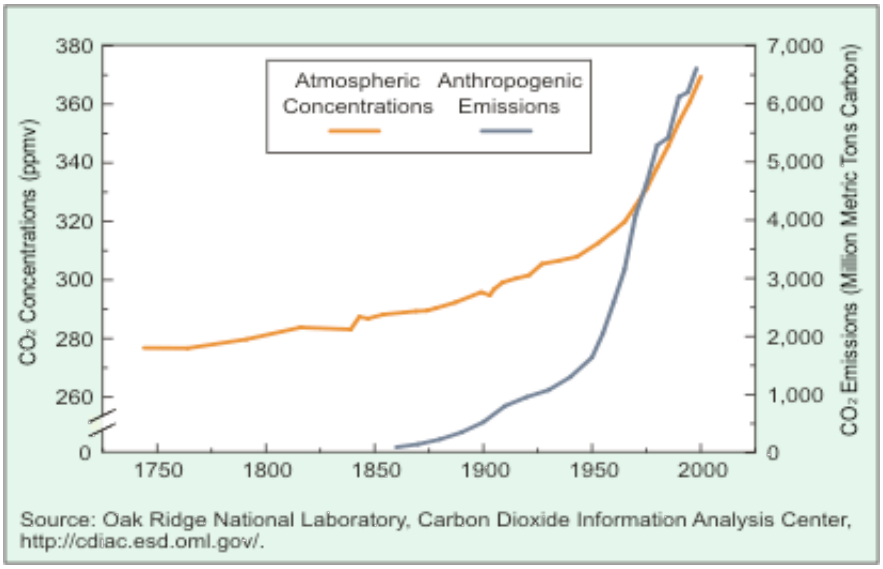
Background Information

What are greenhouse gases?

Our atmosphere contains several chemical compounds that scientists refer to as greenhouse gases. The most common greenhouse gases include (in order of quantity): water vapor (H_20), carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), ozone (O_3), and chlorofluorocarbons (CFCs). These gases allow sunlight to enter the atmosphere freely. After sunlight passes through the atmosphere and strikes the Earth's surface some of it is reradiated back towards space as infrared radiation (heat). Greenhouse gases absorb this infrared radiation and trap the heat in the atmosphere. The atmosphere acts as a natural blanket by preventing the Sun's heat energy from radiating back into space, much like a greenhouse traps the Sun's energy to warm someone's plants even in the middle of winter. The natural greenhouse effect helps warm the Earth's surface by about 33°C. Without it, our planet would be too cold for humans to survive.



Why are scientists concerned with greenhouse gases?
The amount of energy arriving from the Sun to the Earth's surface has to be balanced with the amount of energy radiated back into space, leaving the temperature of the Earth's surface roughly constant. When there is a change in the amount of greenhouse gases, it affects the amount of heat trapped within the atmosphere. There are many natural causes for increases in greenhouse gas levels including volcanic eruptions and forest fires. In the last 150 years, human activities such as burning fossil fuels for industry or transportation, deforestation, large-scale agriculture, and production of chlorofluorocarbons (CFCs) have increased greenhouse gas levels resulting in an intensified greenhouse effect.



Carbon dioxide (CO_2) is the greenhouse gas most discussed when scientists examine the history, causes, and predictions of climate change. While other gases also have an effect on heat, CO_2 released into the atmosphere is greatly affected by human activity. During the past 20 years, about three-quarters of anthropogenic (human-produced) CO_2 emissions came from the burning of fossil fuels.

Laboratory Description

This experiment investigates the ability of an intensified CO_2 atmosphere to absorb thermal (heat) energy. You will compare differences in the heat absorption (changes in temperature) in an unaltered air sample and in an intensified CO_2 atmosphere.

Equipment List

For each laboratory team – You will work in teams of 4.

- ☑ 1 high intensity lamp with a 60 to 100 watt incandescent bulb
- ☑ 2 thermometers *or* temperature probes
- ☑ 2 – 500 ml or 600 ml plastic or glass containers
- ☑ 2 pieces of plastic wrap with rubber bands
- ☑ 2 – 35 g baking soda
- ☑ 1 – 65 ml vinegar
- ☑ 1 – 65 ml water
- ☑ 1 wax pencil
- ☑ Greenhouse Effect Student Handout

Team Work

1. *Each student in your group will have a task. Select these before beginning the experiment.*
    a. ***Temperature monitors (2 students).*** *The temperature monitors read the temperature for each apparatus.*
    b. ***Timekeeper.*** *The timekeeper keeps track of the measurement intervals and tells the other group members when to take measurements.*
    c. ***Recorder.*** *The recorder writes the observations and temperature measurements.*

Step 1: Experimental Set Up

1. Prepare the containers.

a. Container 1
    i. Label container 1 - "control"
    ii. Tape the probe or thermometer to the inside of the container. Be sure to tape the thermometer or probe end at least 5 cm above the bottom of the container. You will be adding liquid to the container and you want to measure the "atmosphere" temperatures inside the container, not the liquid temperature.
        1. If using a thermometer be sure the marks are turned to the outside of the container so you can read the temperature measurements.

b. Container 2
    i. Label container 2 - "CO_2"
    ii. Tape the probe or thermometer to the inside of the container. Be sure to tape the thermometer or probe end at least 5 cm above the bottom of the container. You will be adding liquid to the container and you want to measure the "atmosphere" temperatures inside the container, not the liquid temperature.
        1. If using a thermometer be sure the marks are turned to the outside of the container so you can read the temperature measurements.

c. Pour 35 grams (g) of baking soda into each container.

d. Prepare the cover. You will need to place the covers on the containers **immediately** following the addition of the liquid. If you are using plastic wrap, practice sealing the opening with the rubber band before adding the liquid. To do this, place the plastic wrap over the opening and secure it with a rubber band around the mouth of container.

e. Adding the liquid.

i. Container 1 – “control”
    1. Pour 65 ml of water into the container labeled “control.”
    2. Place the cover on the container labeled “control.”
ii. Container 2 - “CO_2”
    1. Pour 65 ml of vinegar into the container labeled “CO_2.”
    2. Place the cover on the container labeled “CO_2.”
iii. Seal all the containers. Be sure the seals are tight.
iv. Swirl both containers for 15 seconds.

2. Place the containers directly underneath the lamp. The light should be about 24 centimeters over the containers. Both containers should be placed an equal distance from the light source. **Do not turn on the lamp at this time.**

3. Complete the ***prediction section*** **on your investigation sheet.** Predict which container of atmosphere you think will heat the fastest. Which container of atmosphere do you think will reach the highest temperature?

Step 2: Conducting the experiment

Data Collection Overview: The temperature readings for both probes (or thermometers) should be checked and recorded every 2 minutes for a total of 10 minutes. After the 6-minute measurement, you should discuss and note which container has the greatest temperature increase. After the 8-minute measurement has been taken, turn off the light. You will make one more temperature reading at the 10-minute mark.

Procedure

1. **BEFORE:** Measure the temperature prior to turning on the light bulb. Record the temperature in the **BEFORE** column.
    a. It is important to know the temperature both before and after the light is turned on. This provides a starting point so changes in temperature can be discussed accurately.
2. **TURNING THE BULB ON**
    a. Begin timing immediately after turning the light on.

   b. Measure and record temperature in the **0-minute** column on the worksheet.

3. **2-MINUTE INTERVALS:** Take and record temperature measurements on your Greenhouse Effect Data Collection Table every **2 minutes for the first 8 minutes of the experiment with the light on**. Note that the time labels at the top of the data chart are elapsed time.
   a. Record the temperature in the correct time column as needed.
   b. At the end of the **6-minute period**, your team should discuss and note which container exhibited the greatest greenhouse effect (heat increase).
4. **Turn off the light bulb immediately after the temperatures are recorded for the 8-minute interval. You will need to make one more measurement at the 10-minute interval.**
5. Again, discuss and note which container has the greatest greenhouse effect (heat increase).
6. At the 10-minute interval, measure the temperature for each probe (or thermometer)**.**
7. Calculate the **Heat Increase** – the difference between the **start measurement** and **the 8-minute** interval temperature – and record it on your **Greenhouse Effect Data Collection Table**.
8. Calculate the **Heat Retention** – the difference between the **8-minute and the 10-minute intervals** – and record it on your **Greenhouse Effect Data Collection Table**.
9. Complete the **Greenhouse Effect Analysis Questions #1-6** on your investigation sheet.